

REVISED VERSION OF qb-3949

OIL and GAS

in

TASMANIA

MICROFILMED
FICHE No.014153-54

**A Company Profile
of**

GREAT SOUTH LAND MINERALS PTY LTD
ACN 068 650 386

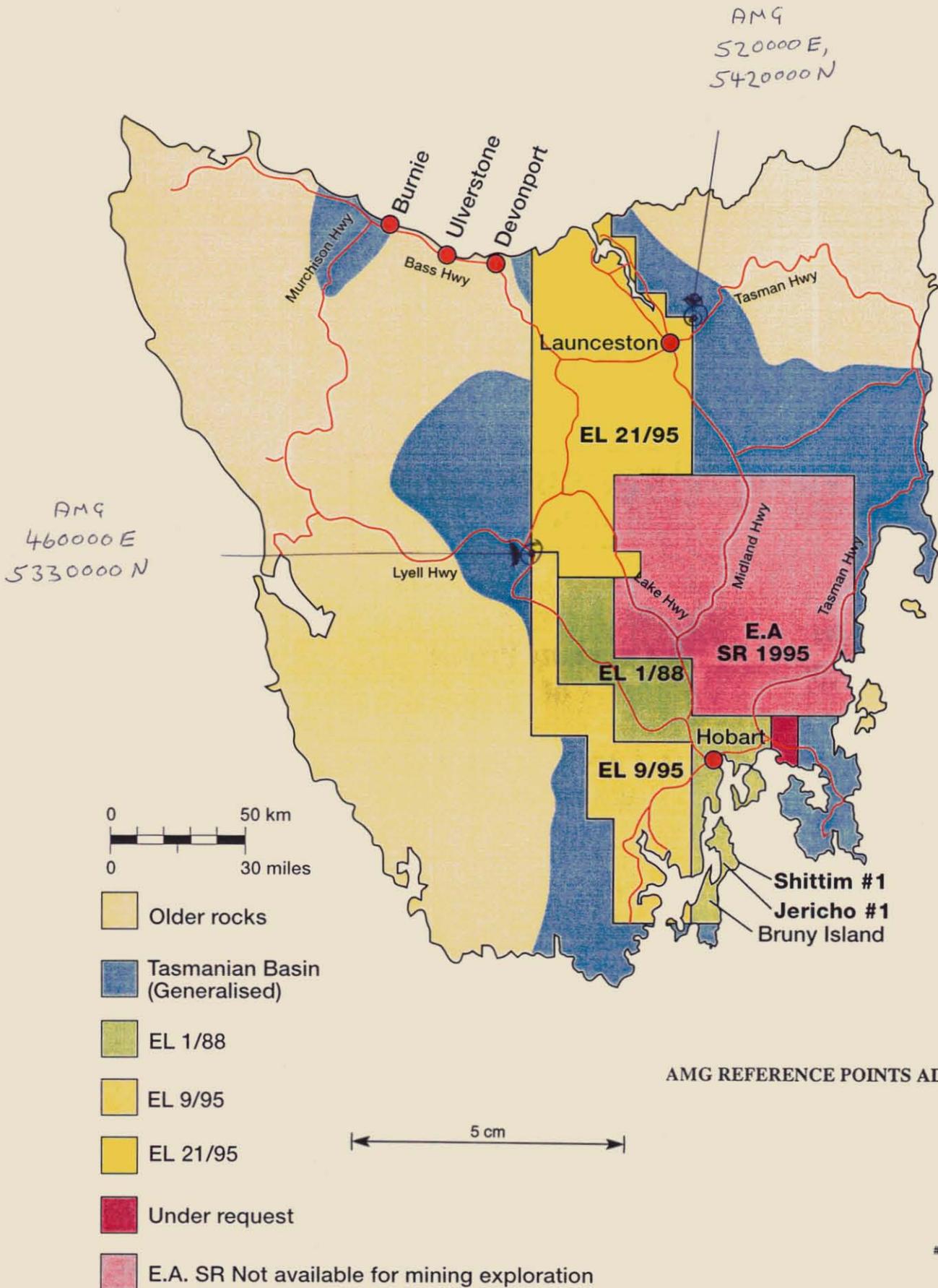
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AMG REFERENCE POINTS ADDED

January 1997

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Exploration Licences in the Tasmanian Basin Owned by Great South Land Minerals P/L



GREAT SOUTH LAND MINERALS PTY LTD (GSM)

The formation of the company

Great South Land Minerals Pty Ltd was formed by a group of people interested in oil exploration in the Tasmanian Basin. In 1995 the company acquired an existing oil exploration licence and shortly after took out two further exploration licences.

It has accelerated previous drilling programs by financing the completion of an existing hole, the drilling of two further exploration holes and the collection of a large amount of geological data. Details of its discoveries are contained later in this document.

Company details are on p21 of this section.

The Exploration Licences

The three exploration licences are EL 1/88, EL 9/95 and EL 21/95. (Note that EA SR 1995 has been excluded from exploration).

The above licences cover an area considered to have economic potential for oil and gas and cover over 70% of the accessible part of the Tasmanian Basin.

The Prospectivity of the Tasmanian Basin

Mr Robert Young, a world authority on oil and gas exploration based in Texas, has reviewed the company's work and data and compiled a report.

Dated March 1996, the report concludes that:

- "all of this builds a good case for finding commercial oil and gas in the Basin...";
- "work to date has certainly established a play for oil and gas..."; and
- "a core hole program to evaluate the Basin and explore for hydrocarbons can be designed. The economic factors for the area are very attractive and would sustain the costs of such a program."

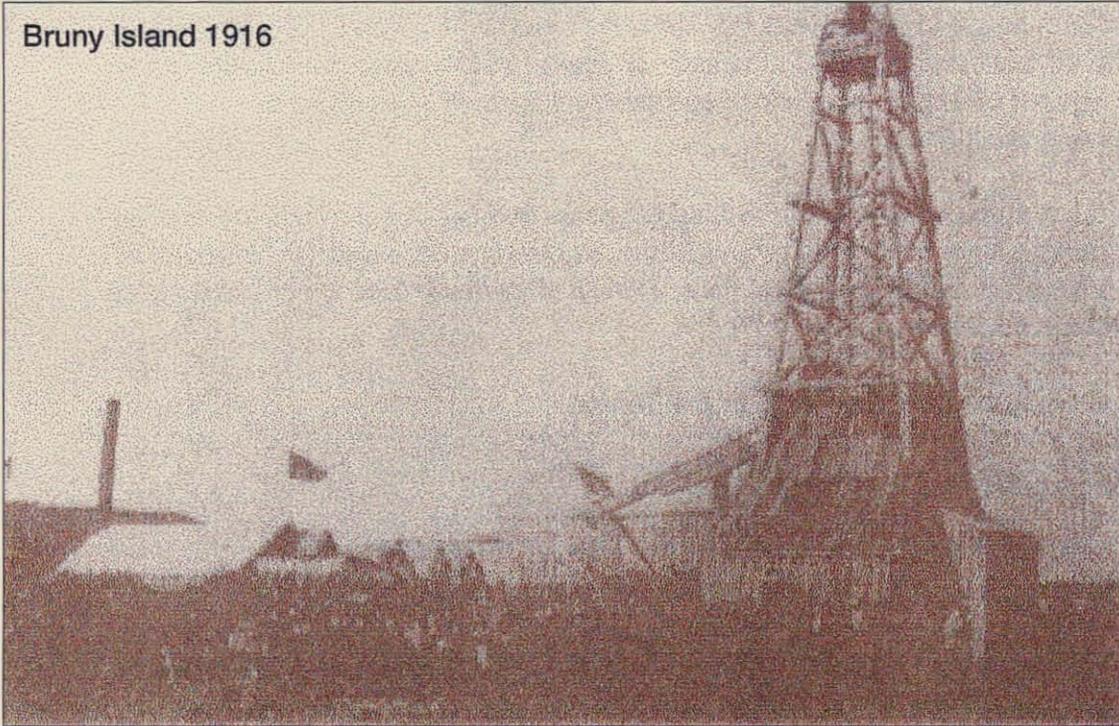
Mr Gerald Carne has reviewed the results of the company's current drilling program at Shittim #1 on Bruny Island, during which quantities of gas and condensate were discovered.

In a letter to the company, dated January 1997, he notes that:

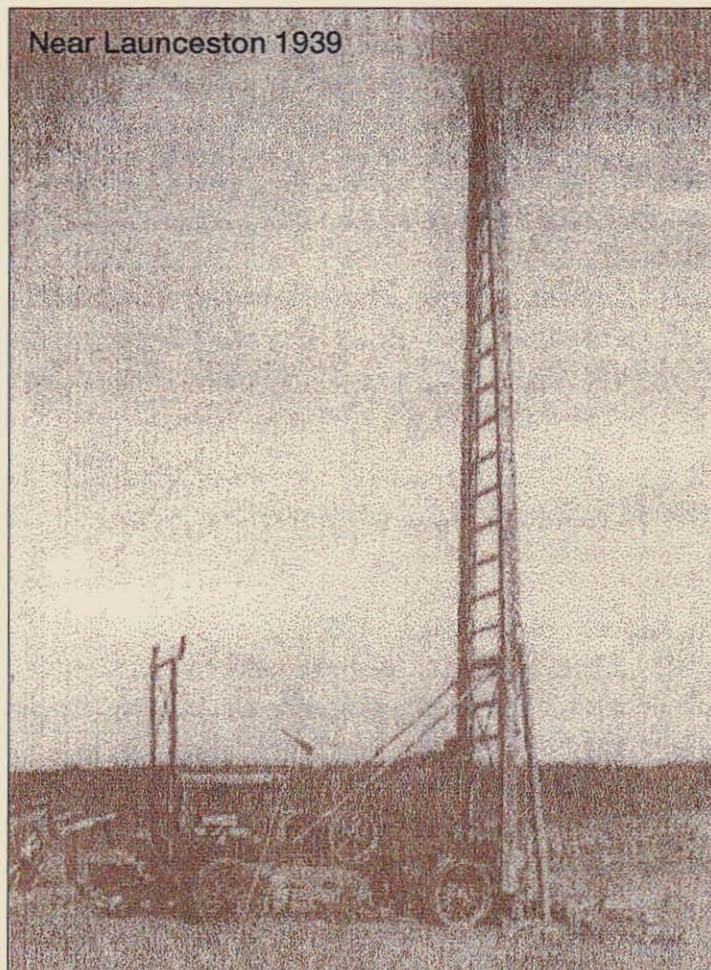
- the recent well was being drilled to evaluate unknown stratigraphy
- the shows are significant and demonstrate that gas, condensate and oil have been generated in the Shittim area
- the identification of gas, condensate and oil (and helium and hydrogen) at Shittim 1B provides considerable optimism towards the future of the onshore petroleum industry in Tasmania.

Drilling for Oil in Tasmania

Bruny Island 1916



Near Launceston 1939



A BRIEF HISTORY OF EXPLORATION

Early Work

The story of oil and gas exploration in Tasmania has been a patchy one, dating from 1915 to the present time.

From 1915 to 1939, and again in the 1960's, several holes were drilled in Tasmania in the search for oil and gas.

However, most of the holes were drilled in the north of the State, and not in what is now currently referred to prospectively as the Tasmanian Basin.

Most of the holes were shallow, due to the limitation in drilling techniques and equipment (see pictures opposite) and the site and location of the exploration was often based on inadequate geological data.

Bruny Island

One of the most encouraging prospects occurred in 1929 when a report from the State Government's Director of Mines Macintosh Reid stated what appeared to be reliable occurrences of oil being present at a place called Johnson's Well on Bruny Island.

In that year the Tasmanian Oil Company drilled a hole at Johnson's Well and it is reported that amounts of oil were discovered at about 30 metres depth. However, the company collapsed with the stock market crash later that year and no further drilling work was done on that site until 1995.

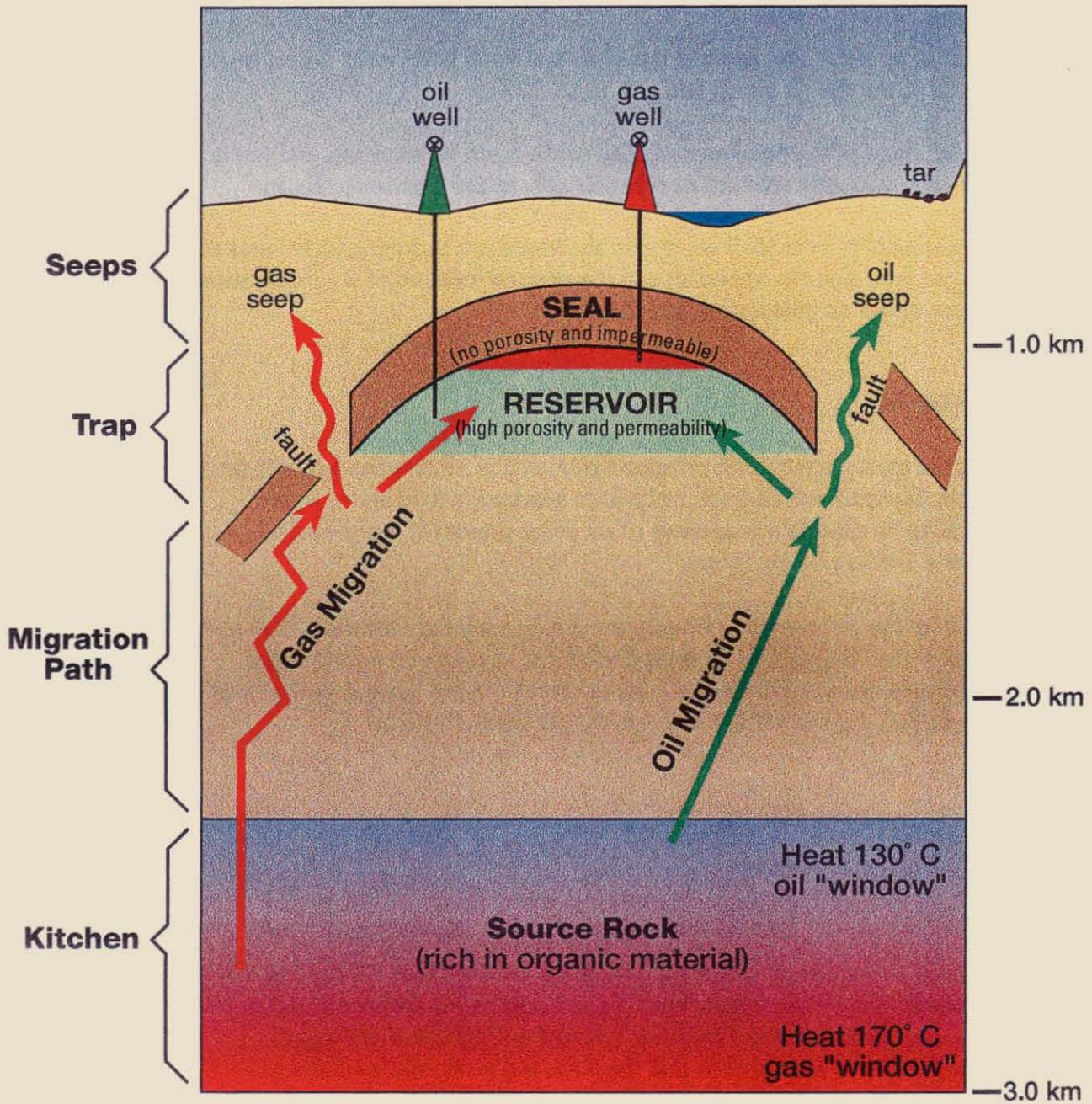
Recent exploration activity

Prior to 1984 very little research on the oil and gas potential of Tasmania was carried out.

From 1984 onwards Conga Oil Pty Ltd, from 1988 Condor Oil Pty Ltd and subsequently from 1995 Great South Land Minerals Pty Ltd continued oil and gas exploration onshore in Tasmania, initiated a program of geological research, and have now proven that the State is a prospective oil and gas province (see pp12,14).

This positive finding has been confirmed successively in reports by three independent consulting petroleum geologists. They are Gerry Carne (1992, 1996, 1997), Jack Mulready (1995), and Bob Young (1996).

Cooking in the "Kitchen"



Oil and Gas Exploration - A General Description

Oil and gas is formed from kerogen, an organically rich material which was deposited mainly in marine sediments millions of years ago.

Common source rocks are shales and limestones.

Oil is produced when these source rocks are heated (due to burial) to around 130°C and gas is produced once these source rocks are heated to over 170°C.

The diagrammatic representation opposite depicts the source rocks as being in a "kitchen" from which the oil and gas migrates upwards to be held in a reservoir rock.

Reservoir rocks need to have high porosity and permeability.

- Porosity means the oil and gas is held in large pores and spaces within the rock
- Permeability indicates that there is an interconnection of the pores which allows the oil and gas to pass through the rock and thus be removed.

Sandstones make good reservoir rocks.

The oil and gas is contained in these reservoir rocks by a seal.

A seal is formed when rocks overlying the reservoir have low porosities and permeabilities, thereby trapping the oil and gas.

Shales and dolerites make good seals.

If the seal is broken, by for example subsequent earthquake activity, oil and gas can bleed to the surface as seeps.

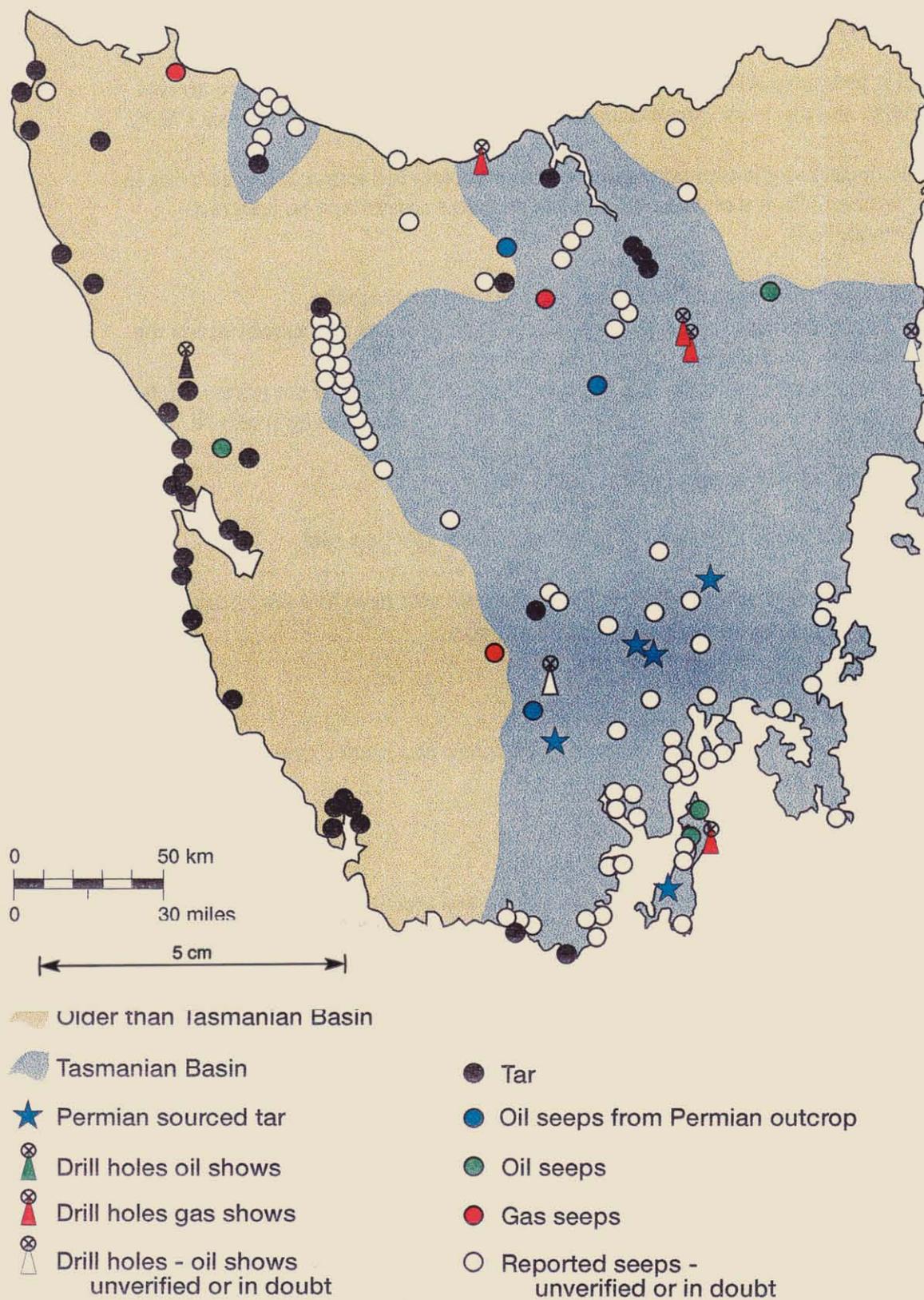
The three elements for the production of oil and gas

i.e. source rocks
 reservoir rocks
 good seals

are known to be present in Tasmania

A number of seeps have been reported in Tasmania and may suggest the presence of commercial quantities of oil and gas in the Tasmanian Basin.

Tasmanian oil & gas seeps, drill holes and tars



Seeps

For many years sightings of oil and tar seeps have been recorded in Tasmania. Over 120 seeps have been reported so far, many from around the perimeter of the Tasmanian Basin. Some of these sightings are more reliable than others, but a number have been verified by geologists (see figure opposite).

Some of these tar seeps are now museum specimens, whilst others have been collected recently in the field. Samples have been geochemically analysed and compared with likely source rocks. The tests confirm that there are at least three likely source rocks that exist deep within the Tasmanian Basin.

Source rocks

These source rocks are the Gordon Limestone (Ordovician), formed over 450 million years ago, the Quamby Formation (Permian) and the Tasmanite oil shale, within it, both formed around 250 million years ago.

A map included later in this presentation shows the level of heating experienced over time by these source rocks. This shows that the older Gordon Limestone appears to be in the oil window in the south and central parts of the Tasmanian Basin, and in the gas window in the north of the Basin.

The younger Permian rocks of the Quamby Formation also appear to be in the oil window and, in some parts, the gas window over most of the Tasmanian Basin

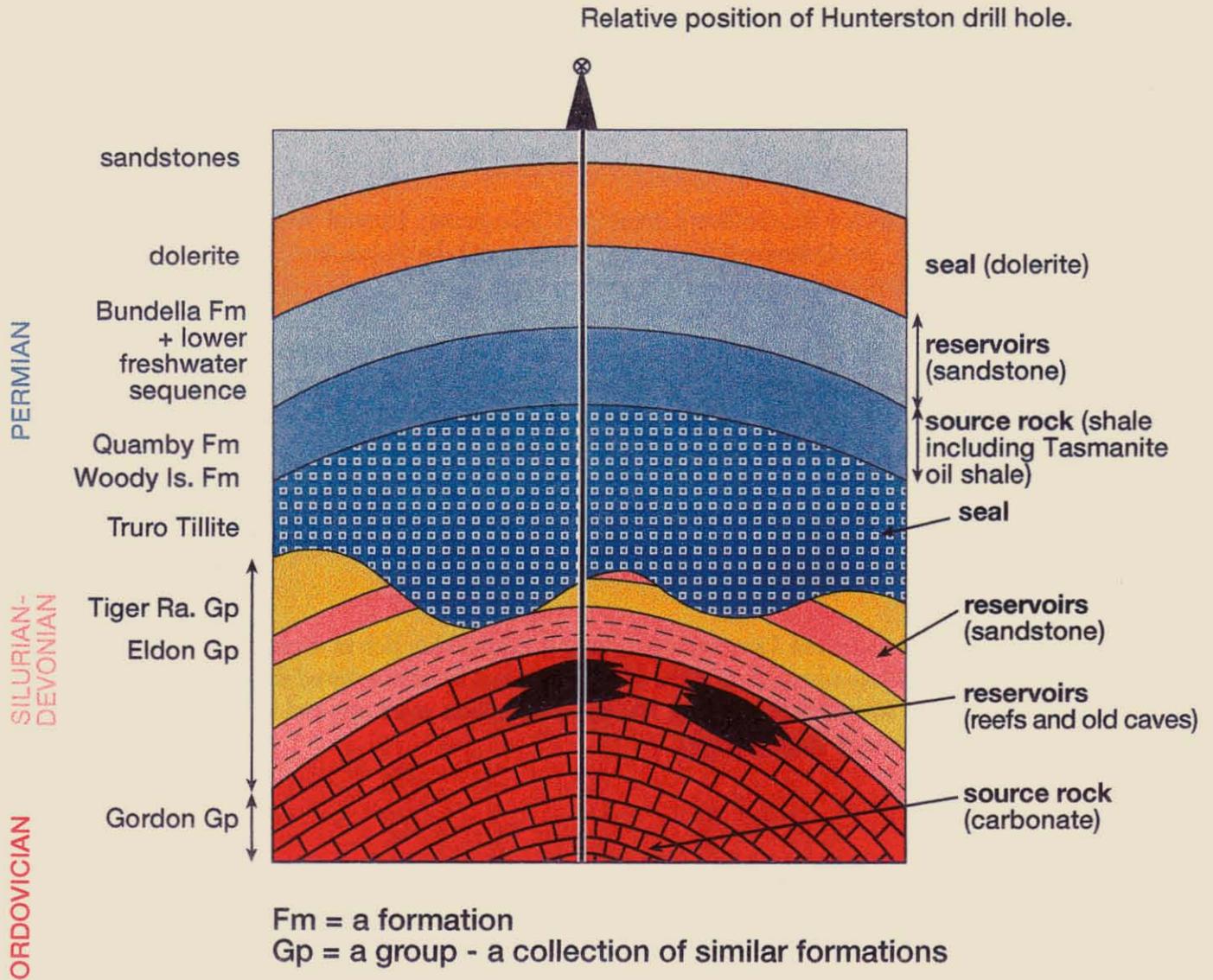
The third source rock (the Tasmanite oil shale) is remarkably rich in organics which may constitute upwards of 25% of it. It appears to have entered the oil and gas window somewhere between 100 and 200 million years ago and is potentially a source of large reserves.

Reservoirs

The next element in considering oil and gas potential is the existence of reservoir rocks. *Potential reservoir rocks exist within the licence boundaries.*

- Within the sandstones of the Permian Period
the Bundella Formation, the Faulkner and Liffey Groups (with good measured porosities and permeabilities)
- Within the rocks of the older Silurian-Devonian Periods
the Eldon and Tiger Range Groups.
- Within the older Gordon Limestone itself, where ancient caves, solution-cavity systems (paleokarsts) and coral reefs are also possible.

Idealised Situation Central Tasmania Possible Structures to be Encountered in Proposed Hole at Hunterston



Reservoirs cont.

The most promising reservoir targets for commercial prospectivity are probably in the (Permian) Faulkner and Liffey Groups which collectively have been called informally the *lower freshwater sequence*. This sequence consists mainly of sandstones and was deposited in broad river valleys and along the coast adjacent to ice-ridden shallow seas.

The importance of the *lower freshwater sequence* is that it is very similar geologically and environmentally to the major oil and gas reservoirs in the Middle East (Oman and Saudi Arabia), South America and the Cooper Basin in Central Australia.

Seals

The next part of the story for discovering oil and gas is the need to have a good seal. And good seals are found in Tasmania.

Within the Permian rocks, shales and mudstone sequences (within what is known as the Parmeener Supergroup) are widespread, impermeable and over 150 metres thick.

And the very widespread hot intrusions of dolerite ('blue metal'), now cooled on average to 250m thick flat sheets (or sills), also make very effective seals, as they have been found to do in the remarkably similar geology of the gas producing Parana Basin of Brazil.

Traps

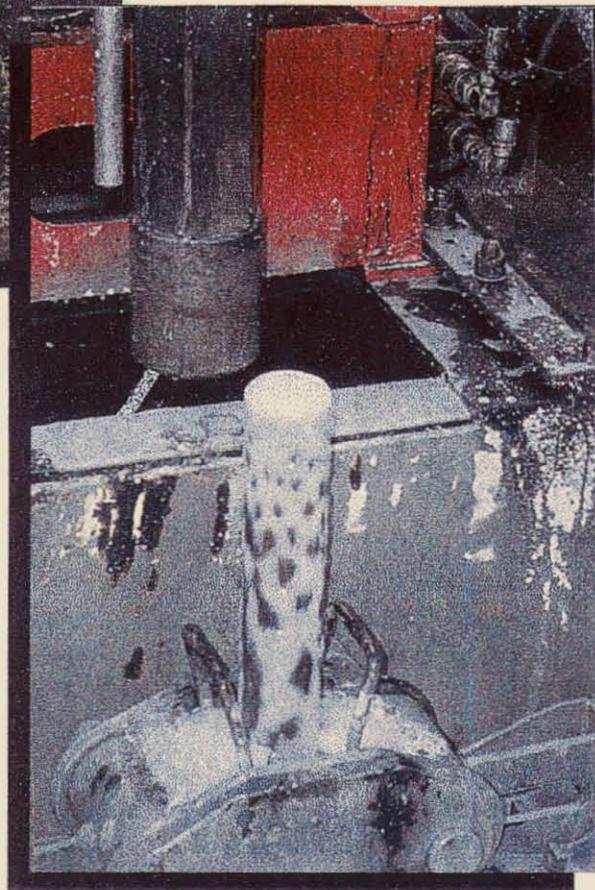
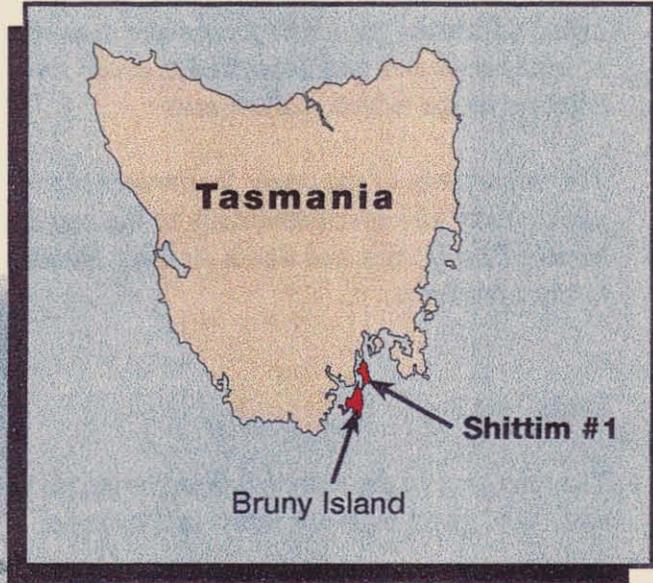
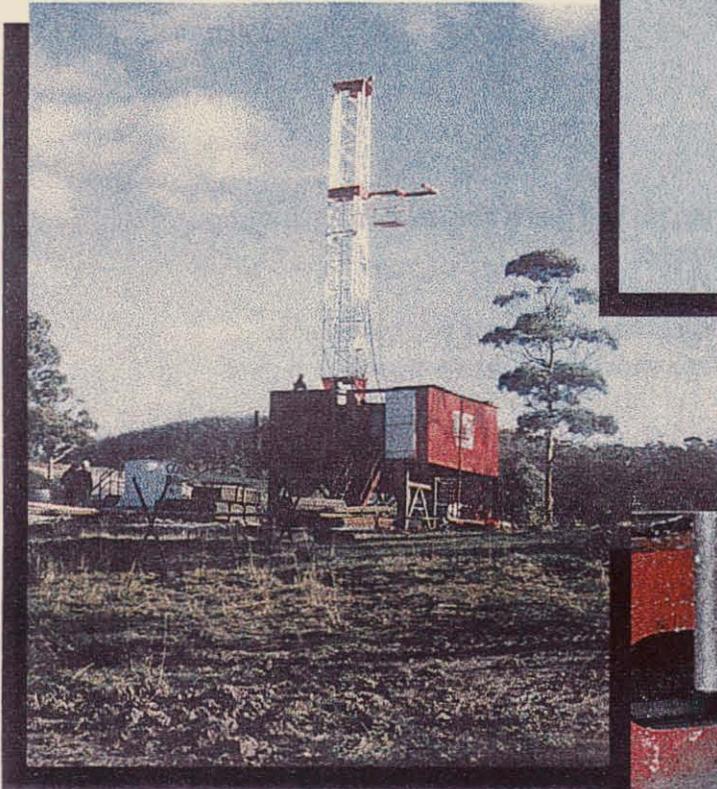
To be able to find oil and gas in commercial quantities it is necessary to have a trap.

Traps are formed basically by structural alterations or deformations which allow accumulations of commercial quantities of oil or gas to form, and can be revealed on seismic studies and by geological mapping.

Domal structures have long been known in Tasmania and these domes can also form commercial traps. They have been mapped in Permian age rocks at the surface and it is believed they extend to depth. At least two such domes exist within the company licences and are at Waddamana (the Hunterston Dome) and Cygnet.

Anticlines (or geological upfolds) are well known in both the younger Permian rocks and the older rocks of the Silurian Period (Eldon Group) and Ordovician Period (Gordon Limestone). These anticlines can also act as traps.

Shittim #1 Well Bruny Island 1996



DISCOVERIES OF GREAT SOUTH LAND MINERALS PTY LTD - DRILLING

Great South Land Minerals P/L has been active in oil and gas exploration since its inception in 1995 and has recently made discoveries which reinforce the possibility of finding commercial quantities of oil and gas in the Tasmanian Basin.

Jericho #1 Well

This well was at a site lying below the level of a dolerite sill. The hole was regarded as exploratory and only went to a depth of 228 metres.

Gas was discovered at shallow depth and the rock type encountered suggested the well might soon hit a significant reservoir, beyond the capacity of the equipment on-site to contain. The hole was therefore cemented and abandoned.

Shittim #1 Well

The first major well drilled by Great South Land Minerals P/L was Shittim #1 on North Bruny Island, some 2.5 k from the Jericho site. It was commenced in 1995 as a stratigraphic (geological strata) hole.

Surprisingly high levels of gas were encountered down to 1021m.

Two thick dolerite sills were cored during the drilling and these appear to have acted as seals for gas encountered at depth in the hole.

Methane of non-biogenic origin was measured up to 8.9% (in air), and ethane (C₂) was first encountered at 1528m. Higher hydrocarbons (propane - C₃ to octane -C₈) were first measured at 1630m and values increased to the bottom of the hole at 1686m.

The ratios of C₂:C₃ show that the gas is typical of "gas associated with oil and gas provinces". Traces of oil are associated with this wet gas, both in the formation water and in crushed core.

Because the rocks at this level are metamorphic and therefore most unlikely to have generated hydrocarbons, it is thought that both the gas and oil have migrated into these rocks through fractures.

Helium, of deep crustal origin, is present in possibly economical percentages in four of the samples and increases in concentration down the hole.

Diagrammatic Cross Section Lower Permian Freshwater Sequence in the Tasmanian Basin

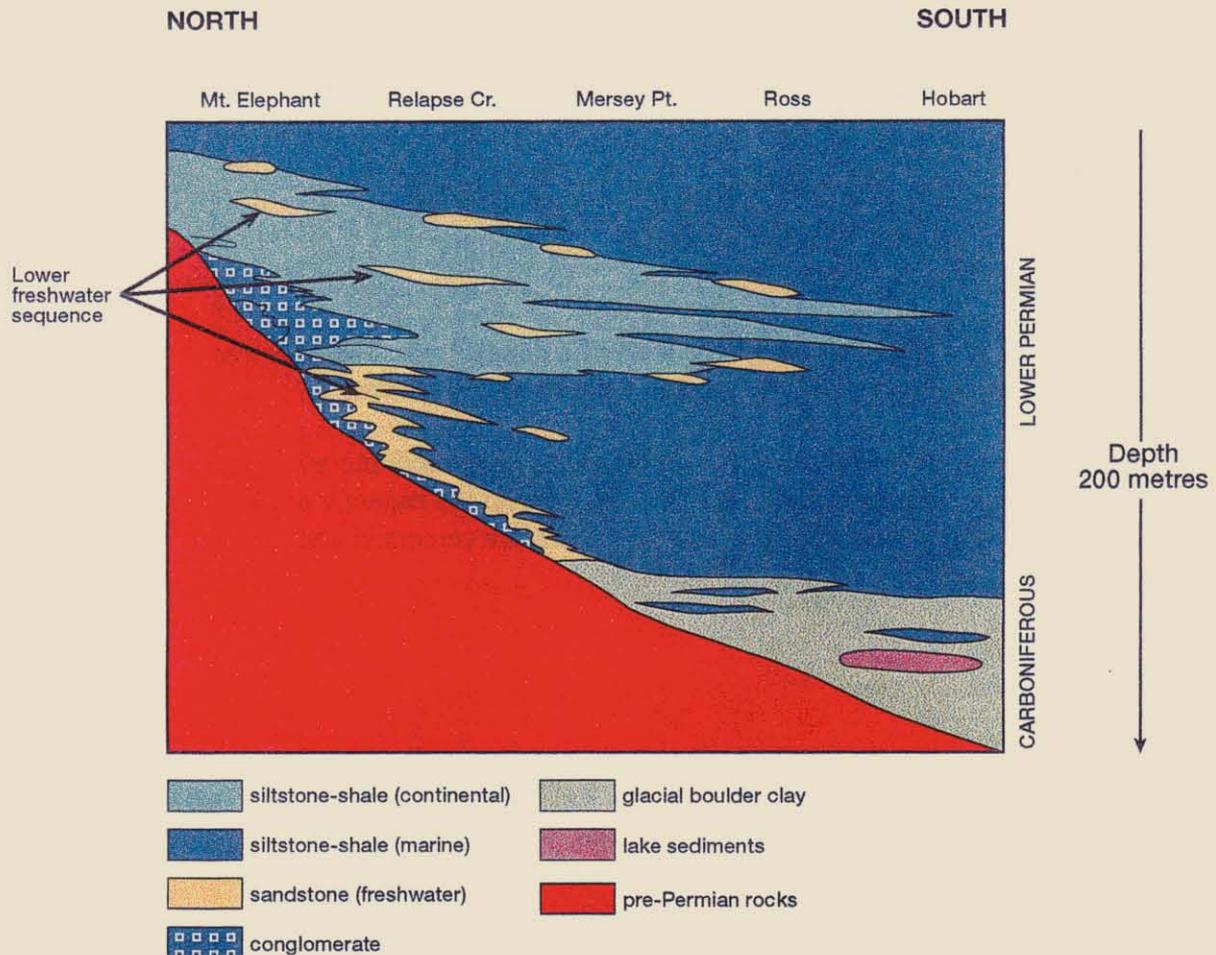


Diagram showing changes in rock types and thickness of the "lower freshwater sequence" of Permian age from north to the south of the Tasmanian basin

(Adapted from work by Martini and Banks)

Conclusions from the AMDEL Report

- Aromatic maturity indicators for the Lonnvale oil seep indicate that it was generated and expelled from a moderately mature source interval. Saturated biomarker maturity indicators ratios support this level of maturity.
- Various aspects of the molecular composition of the sample indicates that the precursor organic matter of the oil seep is likely to have been derived from a mixed algal/terrestrial source containing abundant *Tasmanites* alga deposited in an anoxic, possibly nearshore, marine environment.
- The sample appears to have been subjected to light biodegradation
- The extract is likely to have undergone some migration since generation from its source interval

DISCOVERIES OF GREAT SOUTH LAND MINERALS PTY LTD - OTHER

As well as drilling activity, Great South Land Minerals P/L has been involved in other information-seeking activity.

Geology

Research funded by the company during 1995 (and still ongoing) has shown that the Permian sandstones in the *lower freshwater sequence* are thicker and have higher porosities at the northern end of the Basin

This suggests the existence of significant reservoir rocks in the Lower Permian rocks at the northern end of the Tasmanian Basin (see diagram opposite).

Seismic analysis

The thick dolerite sheets (or sills) have in the past made seismic prospecting difficult in Tasmania and have raised doubts about the usefulness of this technique in finding traps, and therefore assisting in the discovery of oil and gas in commercial quantities.

However, the Australian Geological Survey Organisation (AGSO) has recently carried out seismic work along two short lines in central Tasmania, one near Tunbridge and the other near Strickland.

The company has gained access to this data and had it analysed by a consultant geophysicist. Structures can be seen on both of these lines, which suggests that, with care, this technique can be used in a Tasmanian exploration program and that suitable traps may exist within and beneath the Tasmanian Basin (see diagram on p 19).

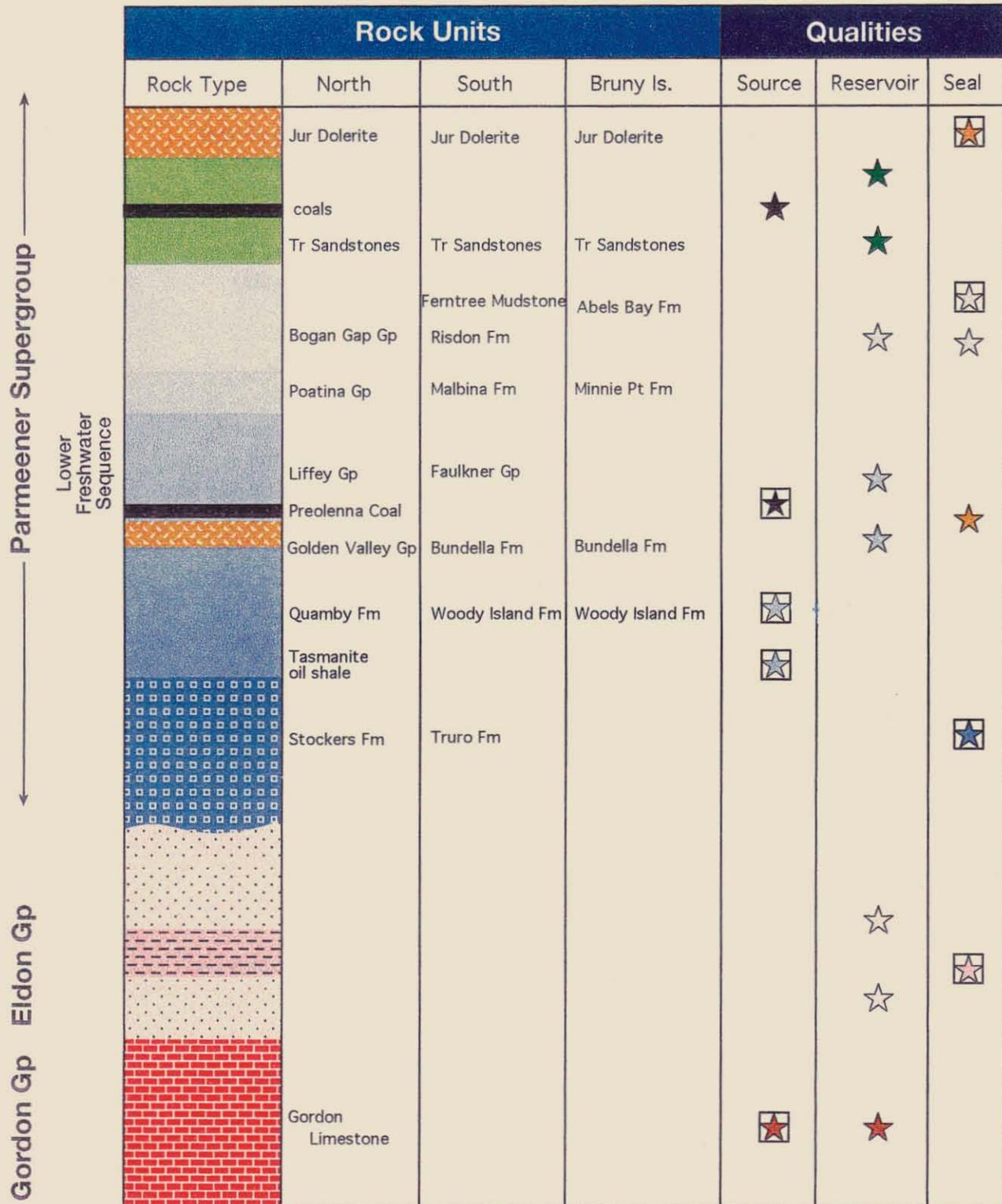
Oil seep analysis

Oils from different sources have distinctive chemical compositions, which are known as finger-prints.

An oil seep recently found at Lonnavale in Southern Tasmania was analysed by AMDEL and found to have been generated from the Tasmanite oil shale. This was previously unknown and proves the Permian sequences can generate oil (see opposite for "Conclusions from the AMDEL Report").

The analysis of this seep also shows it to be a heavy crude with a low sulphur content, a highly desirable commercial commodity.

Diagrammatic Representation of the Parmeener Supergroup (Incorporating the Lower Freshwater Sequence) and older rocks



★ Verified

Exploration strategy of the company

The company's exploration program is aimed at finding areas in the state where all of the elements of the petroleum system come together, and the company will drill where the information to hand suggests that the several **source rocks, reservoirs, seals and traps** are present in the one place.

To generate oil and gas a **source rock, a reservoir rock and a seal** are necessary. And for it to be present in commercial quantities a **trapping mechanism** is also required.

In the last 12 months, Great South Land Minerals P/L has been able to carry out work which until this time was being done in a stop-start fashion. It has established that all of the elements of a petroleum system are present onshore in Tasmania and that commercial quantities of oil and gas may be present.

Seeps have been tied to two **source rocks** (Gordon Limestone and the younger Permian rocks known as the Quamby Formation) and there are at least two other sources.

These **source rocks** would have entered the oil and gas windows at different times. It now appears that the high heat flow associated with the widespread intrusion of the hot dolerite bodies during the Jurassic Period some 135 million years ago would have enabled even the younger Permian strata to enter the oil window.

Potential **reservoirs** exist in the Gordon Limestone, the Eldon Group and in *the lower freshwater sequence*.

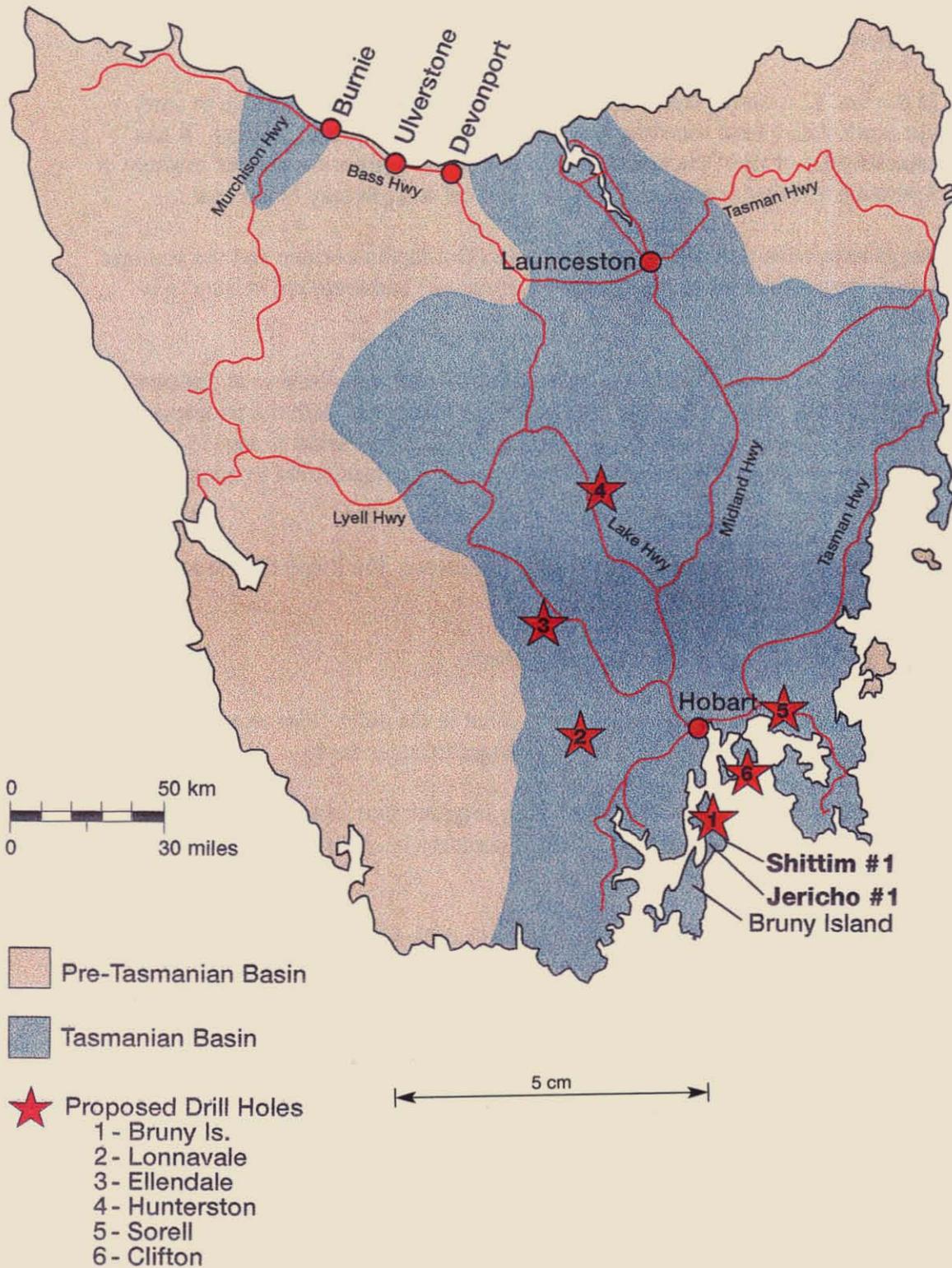
Seals are widespread in the Tasmanian Basin.

Suitable anticlinal **trap** structures are present in the older Gordon and Eldon Groups and domes are present in the younger Permian rocks.

The recently released AGSO seismic data suggests that adequate fault traps may exist under the dolerite sill in which commercial quantities of oil and gas could accumulate.

Gas has already been found in the three wells drilled by the company on Bruny Island.

Proposed Drill Holes in the Tasmanian Basin



The ongoing drilling and general works program

The company has analysed all the results to date and has consulted with a wide range of expertise in the petroleum exploration and geology fields.

As a result of these consultations the company has decided to pursue a three part program over the next two years as follows:

Part 1 Revisit the Bruny Drill holes

- a follow-up program will be continued on Bruny Island, on EL 1/88

Part 2 Seismic survey work

- a program has been formulated covering all three licence areas and involving a minimum line distance of 175 km over certain parts of the Tasmanian Basin where the geology appears to be most prospective

Part 3 An ongoing drilling program

- a shallow hole will be drilled on seep-rich areas near Lonnvale, near Judbury, on EL 9/95.
- a deep hole will be drilled to a depth of just over a kilometre near the thicker part of the Basin near Ellendale, on EL 9/95
- a second deep hole will be drilled on the Hunterston Dome near Waddamana, on EL 21/95
- A further deep hole will be drilled at Sorell, on what appears to be an interesting domal structure
- a shallower hole will be drilled at Clifton Beach, on EL 1/88

The ongoing research program

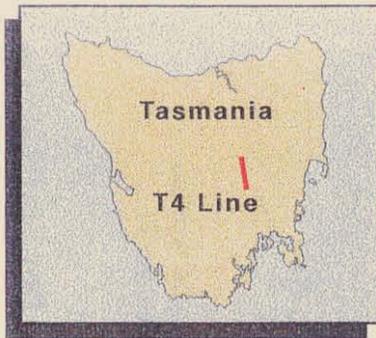
Collaborative research with many persons, groups and agencies have considerably enhanced the knowledge of the Basin.

The company is continuing to pursue collaborative research programs with the Geology Department at the University of Tasmania and is financing three Honours year research projects.

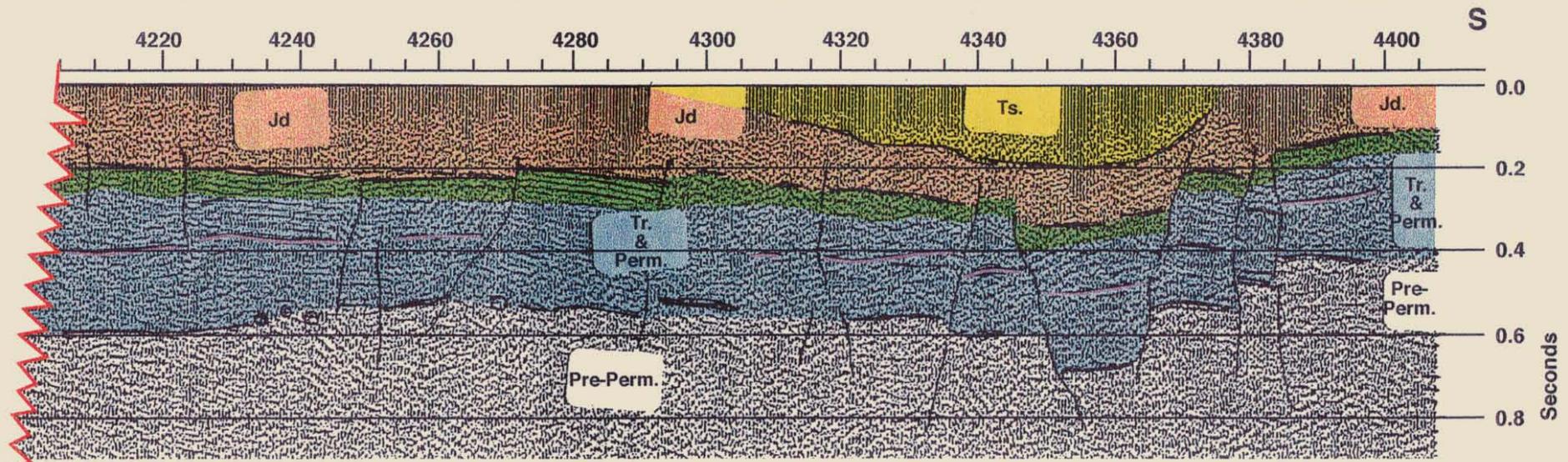
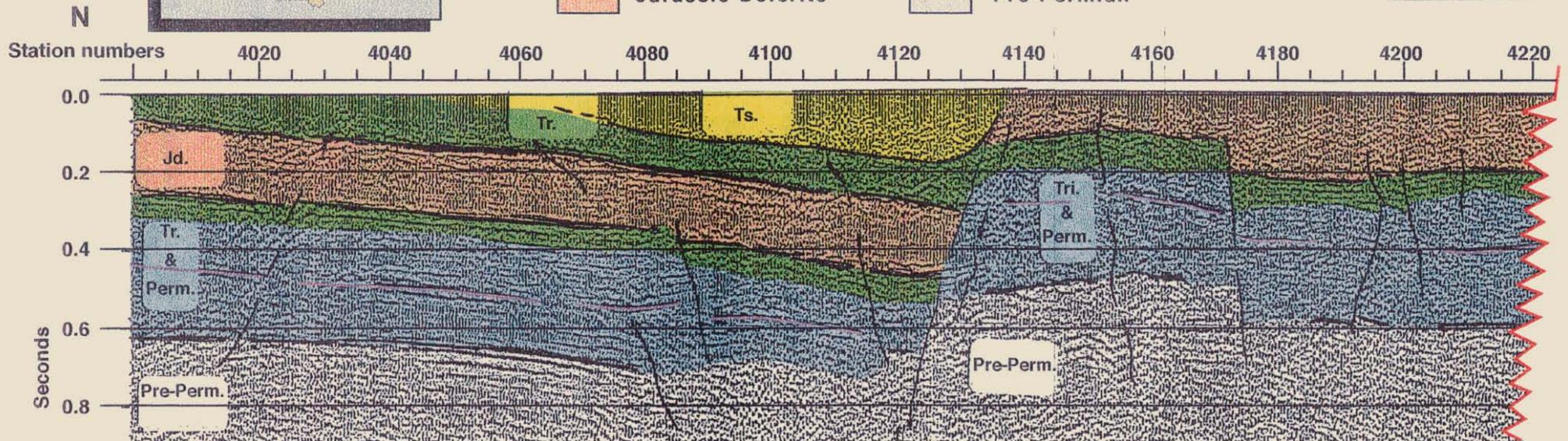
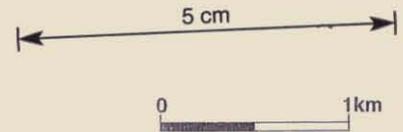
The research project involves the mapping and analysis of the sandstones in the Tasmanian Basin, and the assessment of the maturity of the source rocks.

It has already received the results from last year's project from a graduate who worked on general basin studies, including logging the core from Shittim # 1 and Jericho #1 wells, and geological mapping on Bruny Island.

AGSO (general basin studies) and the CSIRO (geochemical fingerprinting) have current research programs that relate to the company's activities on its licences.



Interpretation of AGSO Seismic Line T4 (1995)



360020

Conclusion

The history of oil and gas exploration in Tasmania has been to say the least haphazard. In past years the high level of mineralisation in Tasmania has concentrated the efforts of geologists and investors in the search for minerals, almost to the total exclusion of oil and gas, and created an ethos that Tasmania is valuable only for its mineralisation.

However the presence and activity of Great South Land Minerals P/L has brought the exploration for oil and gas in Tasmania back into focus. It has carried out a comprehensive drilling program and supported and otherwise promoted ongoing scientific and geological research.

Its recent discovery of the presence of helium, hydrogen and the full range of hydrocarbons in its stratigraphic drillhole on Bruny Island has rapidly extended geological knowledge on the subject of oil and gas in Tasmania.

It is excited about the economic potential of its recent discoveries and is enthusiastic to continue with its program of exploration.

The Government of Tasmania and the Tasmanian Hydro-Electric Commission have been saying for some time now that a new power source will be needed soon to prevent the State from running short on energy supply and to drive the economy of the State forward.

A significant gas find could be reticulated into the major population centres, large industrial concerns, or into gas turbines linked directly to the State electricity grid.

In Australia, oil reserves are falling and a new find is taking on an increasing priority. Even now Australia needs to import heavier grades of crude as production in the country is limited to the lighter grades. And over the next five to ten years a higher proportion of the country's oil needs will need to be imported.

A significant oil discovery in Tasmania would have widespread and positive ramifications for the country and for the State.

Great South Land Minerals P/L intends to actively pursue its exploration program in the Tasmanian Basin to secure an energy rich future for Tasmania.

The Corporate Directory of Great South Land Minerals Pty Ltd

The company presently has 6 directors and 11 shareholders.

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Tasmania 7004

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Fax: (03) 6224 2227

Directors

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Dr Julian Amos

Dr Clive Burrett

Mr Malcolm Bendall

Mr David Bendall

Mr David Wise

Chairman

Managing Director

Director, Chief Geologist

Director, Special Projects

Director

Director

Accountants

Ian Ross

15 Gladstone Street

BATTERY POINT 7004

Tel: (03) 6234 7533

Solicitors

Barnett Walker

81 Salamanca Place

HOBART 7000

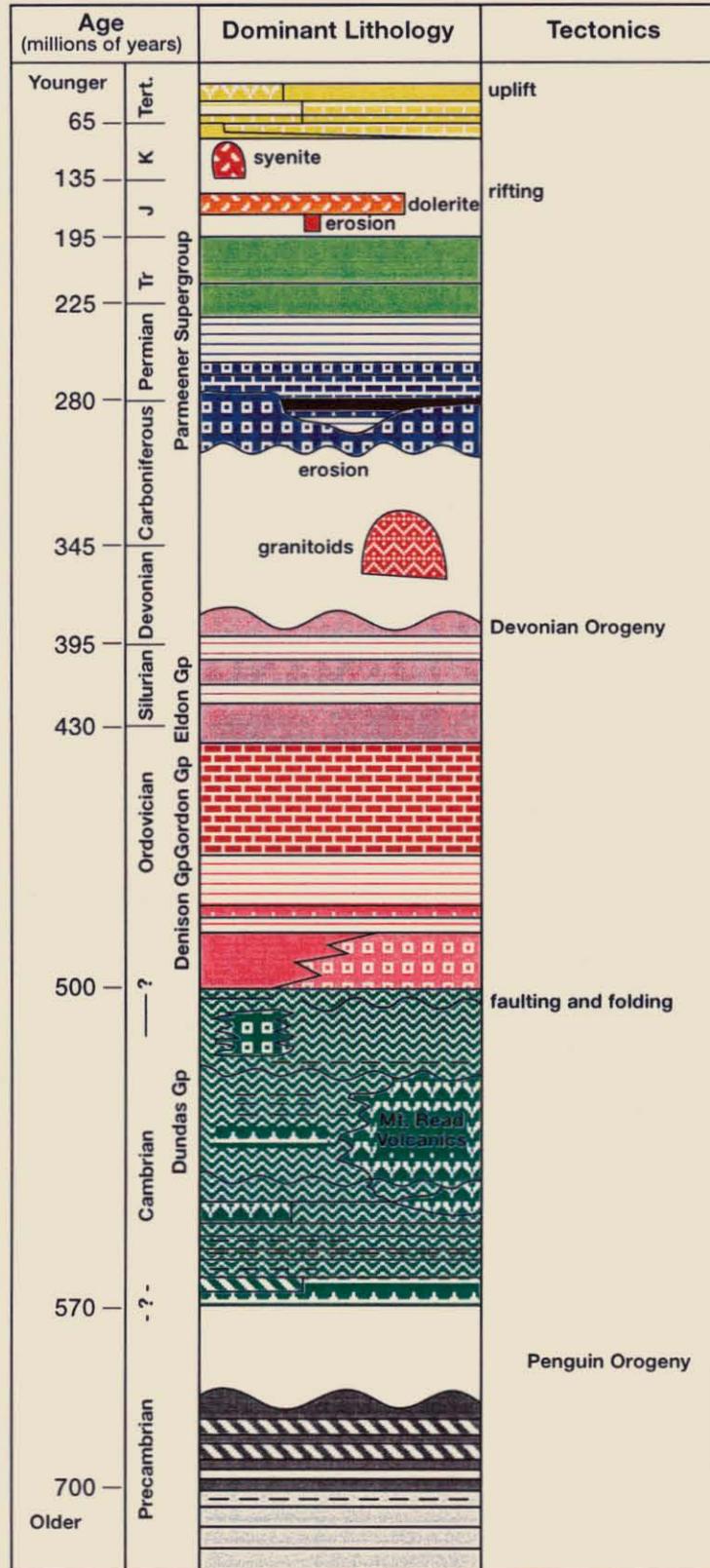
Tel: (03) 6223 5844

OIL AND GAS
in the
ONSHORE TASMANIAN BASIN

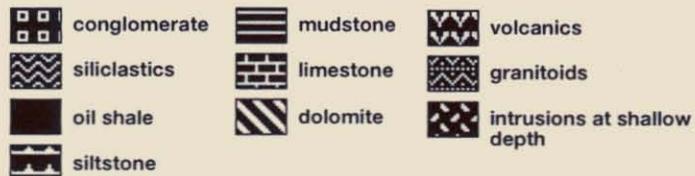
Clive Burrett
Geology Department
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January 1997

Generalised Geological Column for Tasmania



Rock Types



Abstract

The recent discovery of thermogenic gas in a drillhole at Bruny Island has substantially enhanced the prospectivity of the Tasmanian Basin for economic hydrocarbons. Helium may also be present in economic grades.

At least four seep types have been characterised in Tasmania.

One seep type is identical geochemically to the Type I (oil prone) extremely TOC-rich Lower Permian Tasmanite Oil Shale. This excellent world-class source rock oil shale is interbedded with fair to good TOC Type III (gas prone) shales of the Quamby and Woody Island Fms, is within the oil and gas windows over most of the Tasmanian Basin and is much more widespread than previously thought.

A sequence of middle Permian glacial sandstones belonging to the Liffey and Faulkner Gps have good porosities and permeabilities and are found mainly in the north of the Basin. These sandstones thin towards the south where they interdigitate with glacial sandstones of the Bundella Fm, which in the Shittim #1 stratigraphic well on Bruny Island also have good porosities and permeabilities. The 35m thick sandstones have a 10% porosity over much of the northern half of the Basin and can be compared with glacial reservoir sandstones in Oman and the Cooper Basin.

The emplacement of thick and widespread Jurassic dolerite sills would have increased the regional geothermal gradient, increased the overburden on the source rocks by at least 250m, probably brought some sources to maturity over a wide area and on cooling would have produced very effective seals.

Maturation modelling suggests that significant expulsion of oil and gas may have occurred soon after Jurassic and Cretaceous structuring. Tertiary reactivation of old faults and new faulting may have breached the dolerite seals but would have created new structures to receive the newly mobilised hydrocarbons.

Non-biogenic methane has been encountered continually but in varying quantities whilst coring the 1686m of Shittim #1 on Bruny Island. The gas contains high values of methane and significant quantities of C₂-C₈ below 1630m, together with traces of oil with a high pristane-phytane ratio. C₂:C₃ ratios show this gas to be very similar to gases from gas-oil provinces.

As this gas and trace oil is found in a highly deformed metamorphic sequence it has probably migrated in, either laterally or vertically. The gas includes very promising values of up to 1.62% of helium (air-corrected).

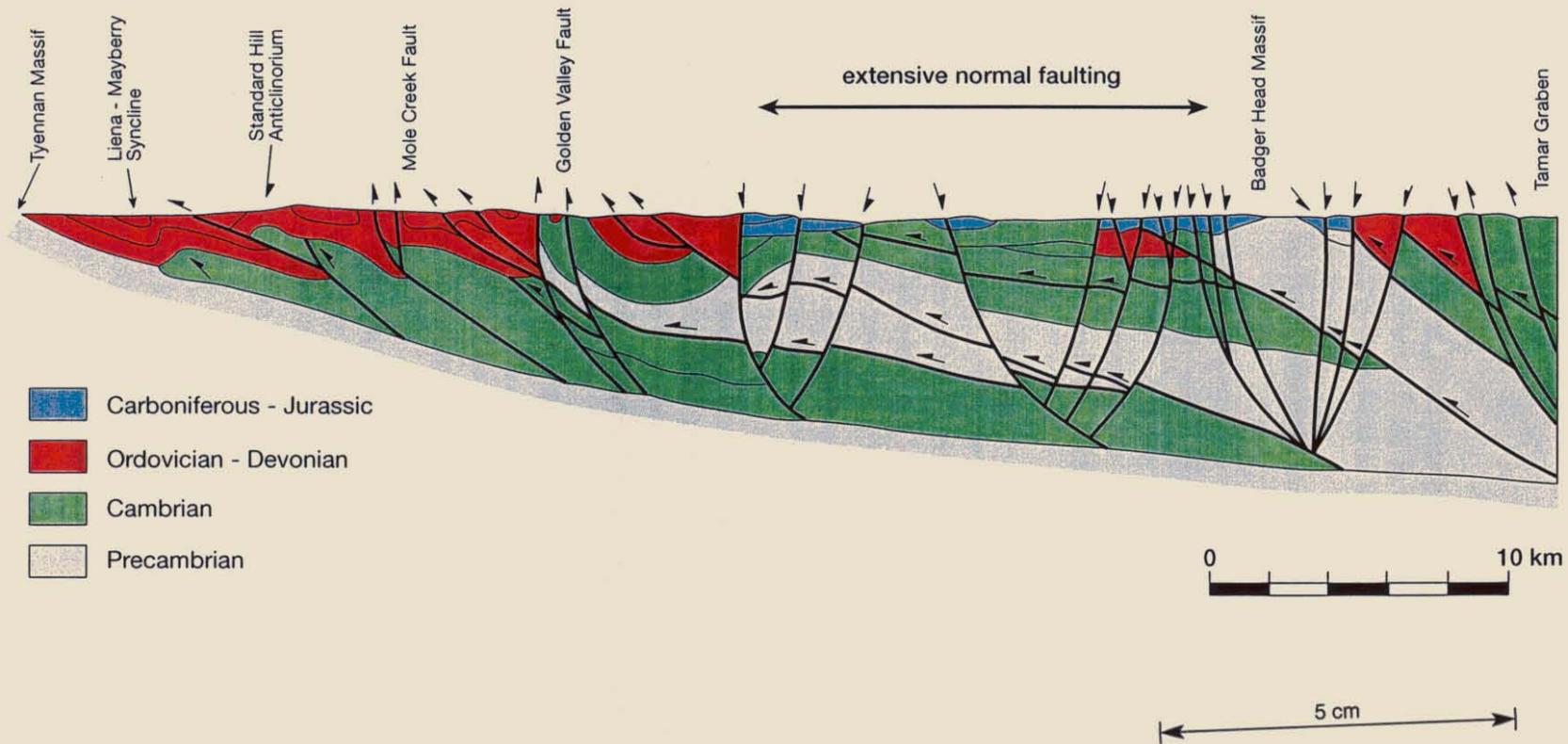
The recent recognition of widespread, potentially prolific Permian source rocks within the oil and gas windows which are stratigraphically under a good reservoir sequence, together with the demonstration by AGSO that seismic exploration is possible, enhances substantially the prospectivity of the Tasmanian Basin, particularly in the northern half.

Results of Mid-Devonian Deformation in Northern Tasmania

(From Woodward et al 1993)

West

East



#97102-8

Figure 2

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Introduction

Seeps of oil and gas have been reported in Tasmania for many years.

There were reports of oil being encountered in a shallow well on Bruny Island in southern Tasmania in 1929. The unsuccessful northern Tasmanian Mersey Valley 'oil boom' of the 1920's (Bacon, 1996) was based mainly on direct drilling of shallow occurrences of thermally immature Tasmanite Oil Shale ($R_o = 0.5$, Baillie, 1987).

Since 1981 there has been a systematic investigation of the oil and gas potential of deeper parts of the onshore Tasmanian Basin carried out successively by Conga Pty Ltd, Condor Pty Ltd and since early 1995 by Great Southland Minerals Pty Ltd.

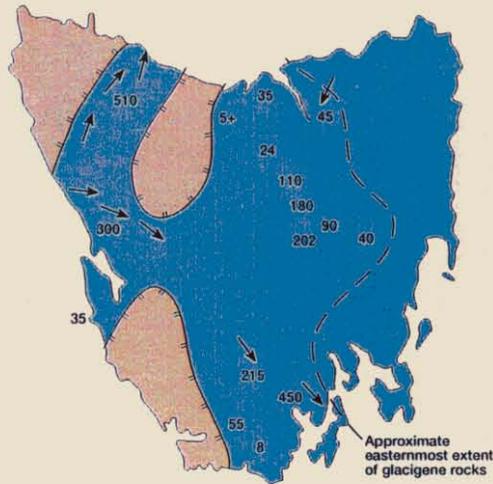
Geochemical, geophysical and geological data collected by these three companies are summarised herein. Also included are recent data and interpretations produced by the Australian Geological Survey Organisation (AGSO-formerly the Bureau of Mineral Resources-BMR), graduate students at the University of Tasmania, the Commonwealth Science and Industrial Research Organisation (CSIRO) and the Tasmanian Mines Department.

Recent geological, geochemical and geophysical results suggest that there is a valid hydrocarbon play in the Paleozoics of the Tasmanian Basin. This conclusion has been confirmed successively by three independent consultants (Carne, 1992, 1997; Mulready, 1995; Young, 1996).

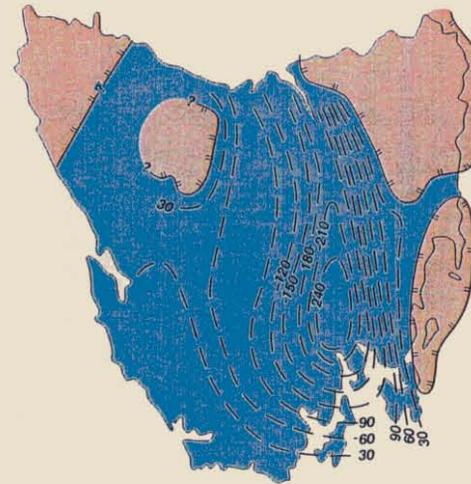
Recent geochemical results on gases from between 1630m and 1686m in the Shittim #1 hole on Bruny Island are particularly encouraging and suggest the possibility of economic quantities of both hydrocarbons and helium.

Paleogeographic development of the Tasmanian Basin from the Late Carboniferous to the Late Permian (from Clarke in Burrett and Martin 1989)

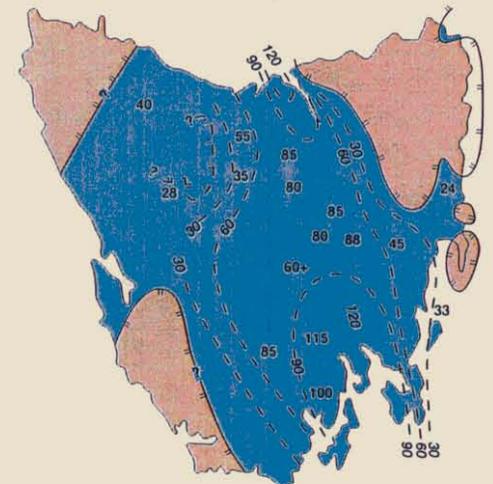
-  Land area
-  Isopach in metres
-  Direction of ice movement.
Thickness of glaciene rocks in metres
- C** Principle cool development
-  Successive brief, more open marine incursions
-  Maximum extent of marine Lower Bernacchian rocks
- 100** Total thickness of marine Bernacchian rocks in metres
- 63** Thickness of Upper Bernacchian rocks (m)
-  Southern limit of Bernacchian rocks due to Lyimingtonian overstep



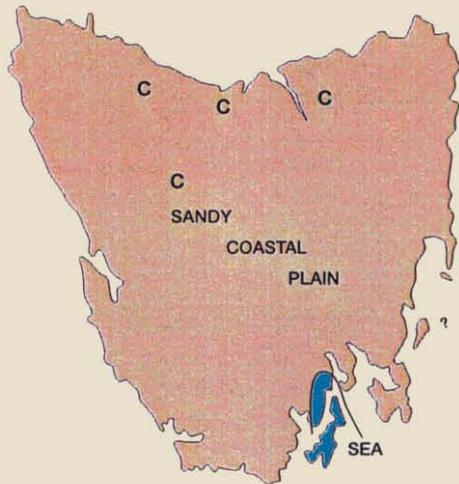
(a) Late Carboniferous glaciation



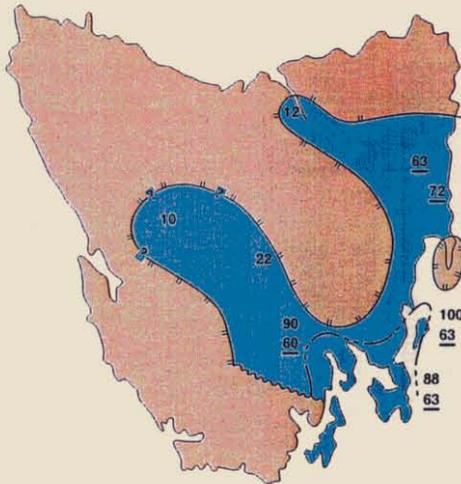
(b) Latest Carboniferous
- earliest Permian/glacimarine shales



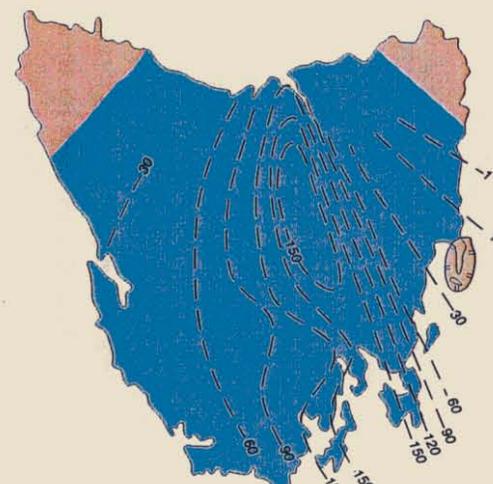
(c) Middle to Late Tamarian



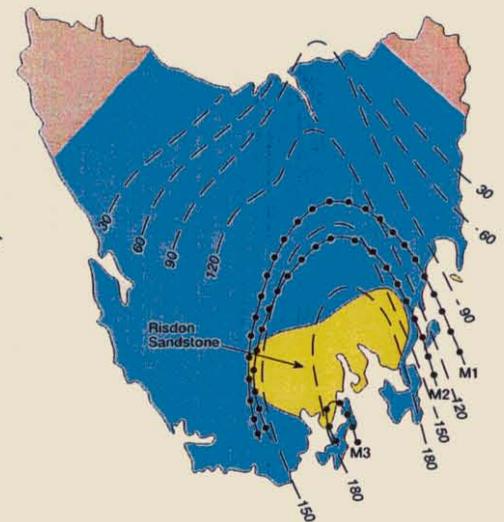
(d) Early Bernacchian non-marine interval
("lower freshwater sequence")
- potential reservoir sequence



(e) The main Bernacchian
marine interval



(f) Early to Middle Lyimingtonian



(g) Late Lyimingtonian

#97102-2

General Geology

The most recent summary of the geology of Tasmania is that edited by Burrett and Martin (1989).

The oldest rocks in Tasmania are Proterozoic schists and phyllites (see Fig.1) and occur in the Tyennan Region of central Tasmania and the Rocky Cape Region of northwest Tasmania. These are unconformably overlain by shallow water, often dolomitic, sequences of Late Proterozoic age. These Precambrian regions, originally thought to be autochthonous and acting as 'geanticlines' in the Cambrian are now known to be allochthonous.

The Cambrian sequences consist of the Mt Read Volcanic arc in the west interfingering westwards with basinal Dundas Gp siliciclastics. Cambrian volcanogenic sequences are probably found at depth under several parts of the Tasmanian Basin, including under north Hobart.

Deformation in the Late Cambrian led to the 'molasse' of the Owen Conglomerate, followed by the sandstones of the Moina Fm, the shales and silts of the Arenig Florentine Valley Fm and the 600-1500m thick tropical, fossiliferous, shallow-water limestones of the Middle-Upper Ordovician, known as the Gordon Gp. In parts the Gordon Gp carbonates are reefal forming a fringe to a miniplatform that deepens to the south and the east.

The Gordon Gp limestones are overlain conformably, and in places disconformably, by the siliciclastics of the the Upper Ordovician-Middle Devonian Eldon Gp in the west and the Tiger Range Gp in central Tasmania. These dominantly shallow water Ordovician to Devonian sediments deepen towards the eastern half of the state where the Ordovician to Middle Devonian is represented by the basinal turbidites of the Mathinna Gp.

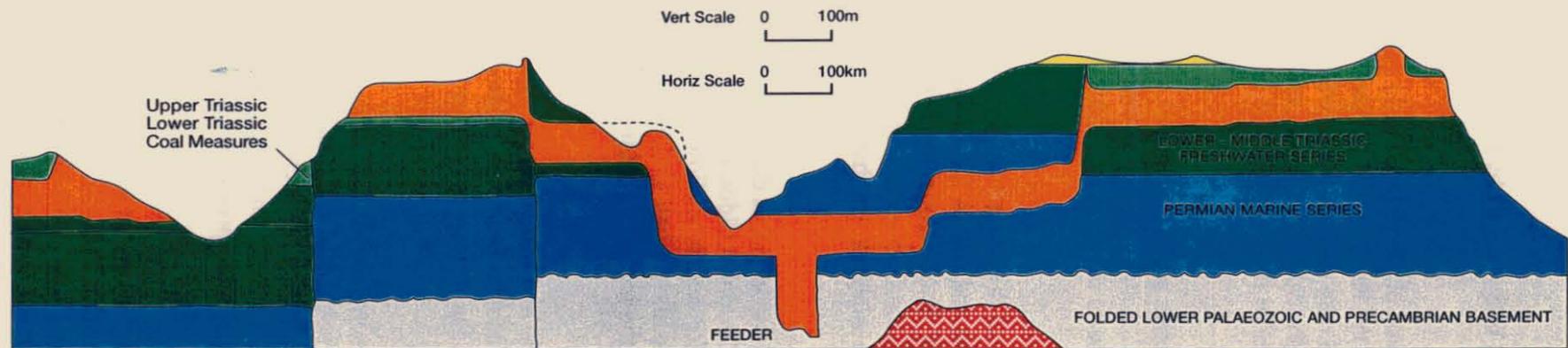
These shallow water (in the west and central Tasmania) and basinal (in the east) Lower-Middle Paleozoics were deformed during the Middle Devonian Tabberaberan orogeny into a typical fold-thrust belt (see Fig.2) with the widespread intrusion of granitoids, particularly in the east and west.

The downwarping leading to the Tasmanian Basin was initiated in the Late Carboniferous with a depositional axis approximately coincident with the Early-Middle Paleozoic paleogeographic (and possibly structural) transition between western and eastern Tasmania (see Fig.3). Initiation of the Tasmanian Basin may be due to simple lithosphere stretching or to more complex stretching and widespread half-graben formation.

The sedimentary rocks of the Tasmanian Basin (see Fig.3b) are collectively known as the Parmeener Supergroup with the dominantly glacial-marine Upper Carboniferous-Permian comprising the thick Lower Parmeener (ave is 850m - range 645-981m) and the Triassic fluvial sandstones, coals and silts comprising the Upper Parmeener Supergroup (ave is 550m - range 365-655m) (Summons, 1981, p.5).

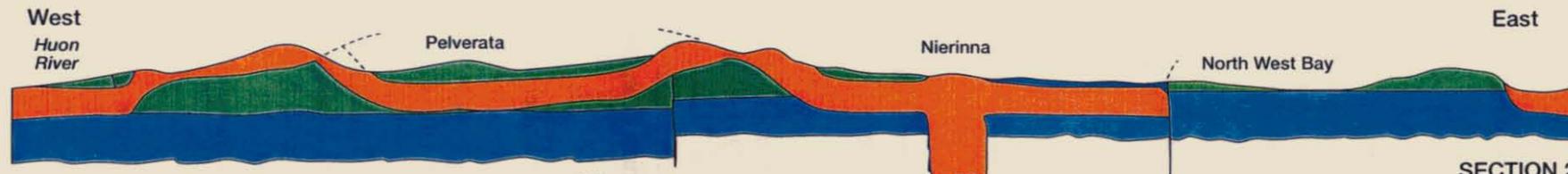
Diagrammatic Summary of Dolerite Intrusion Forms and Structural Sections in the Southern Tasmanian Basin

(from Leaman 1975)

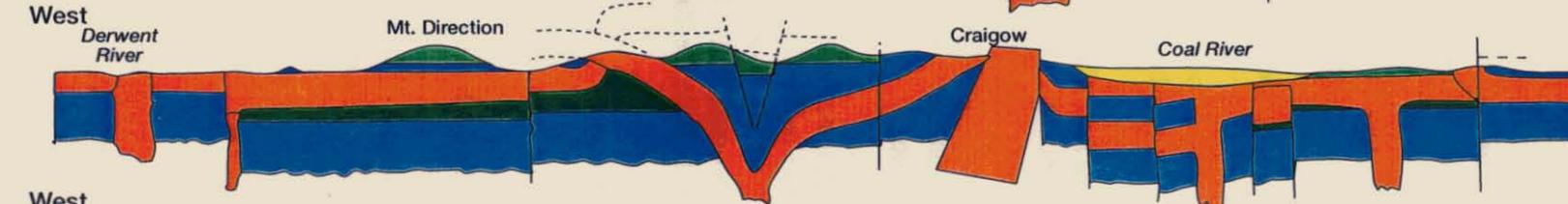


INTRUSION FORMS

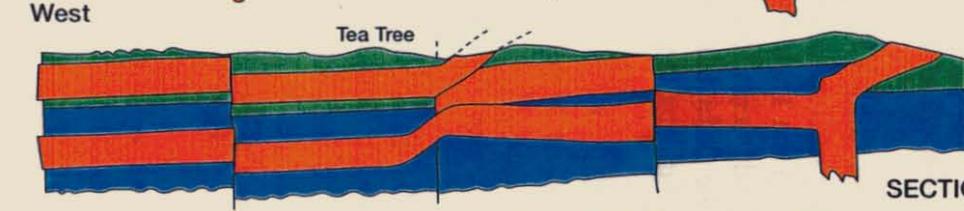
SECTION 1



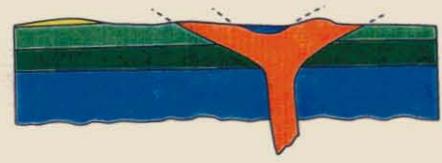
SECTION 2



SECTION 3



SECTION 4



SECTION 5

STRUCTURAL SECTIONS



Figure 4

The glacial marine Lower Parmeener includes a 60-100m thick sequence of mainly glacial fluvial sandstones which are known informally as the 'lower freshwater sequence' and formally as the Liffey Gp (in the north) and the Faulkner Gp (in the south)(see Fig 3d). These sandstones thicken from south to north and have been studied by Martini and Banks (1989). They are a good potential reservoir comparable to other Gondwana glacial fluvial sands such as those in the Cooper Basin of Australia (Maynard, 1996).

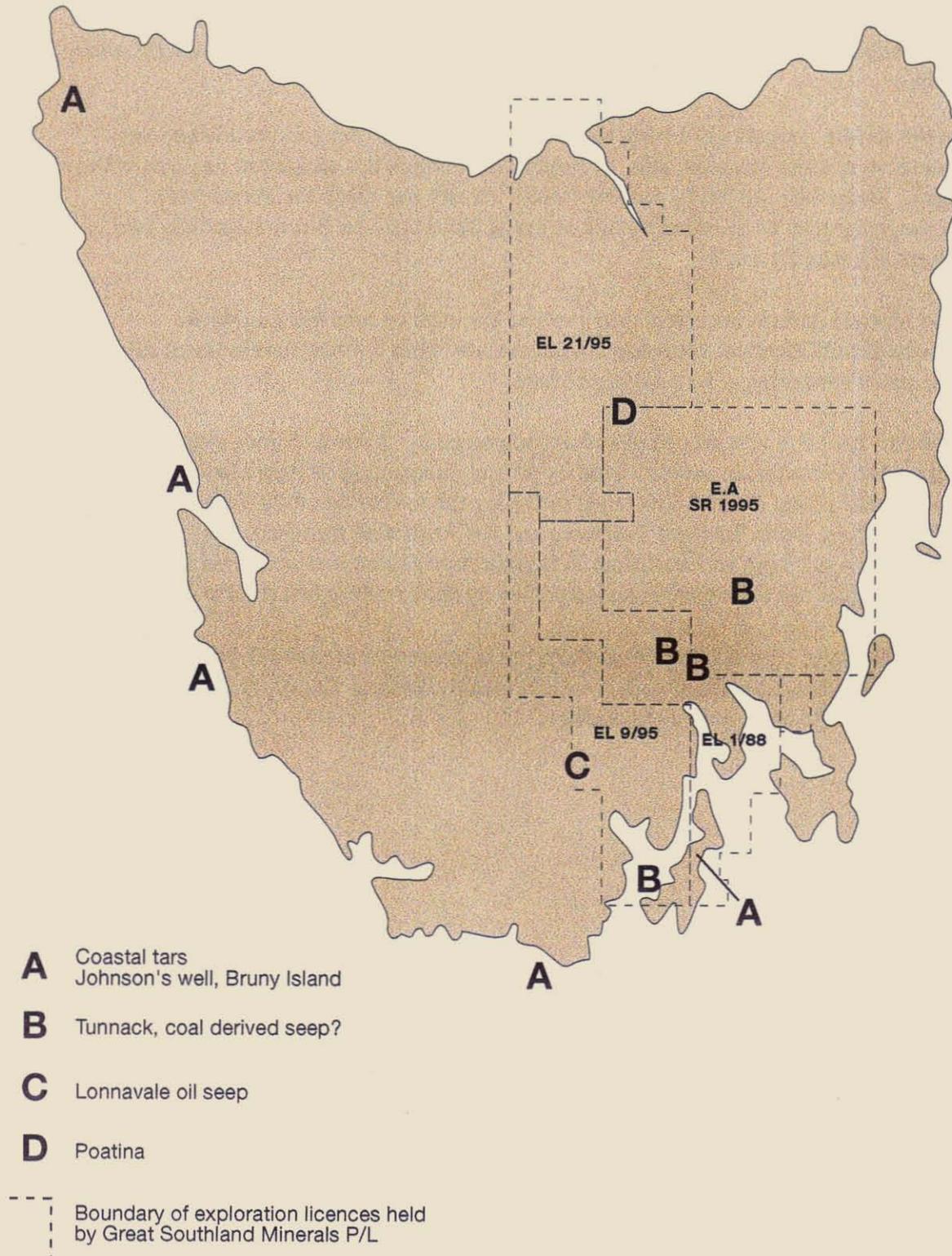
In the middle Jurassic (174 Ma), the Parmeener Supergroup was intruded by very extensive dolerite (diabase) sills, averaging 250m thick but which can be up to 600m thick. These sills are fed by narrow dykes. At any one place the Parmeener Supergroup may be intruded by one or (as at Shittim #1 on Bruny Island) by two major sills (see Figs.4, 8).

The Jurassic dolerite probably only reached the surface near Ida Bay where geochemically identical volcanics are interbedded with a minor development of silts and sands containing a Jurassic macroflora.

Dolerite intrusion was preceded and accompanied by faulting. Minor syenites intruded during the Cretaceous, accompanied by further extensional faulting associated with widespread rifting around Tasmania, including the formation of the 'failed arm', offshore Bass Basin between Tasmania and the Australian mainland. Fission track dating from northern and northeast Tasmania shows there was uplift and considerable denudation in the Cenomanian accompanied by fault reactivation (Hill *et al*, 1995).

In the Tertiary, crustal extension caused the extension of narrow rift valleys and half grabens which were infilled with river and lake sediments. Locally volcanic centres erupted significant volumes of basalts.

Distribution of Seep Types



Seeps and Source Rocks

Three major types of Tasmanian seeps have been recognised geochemically (types A,B and C). A fourth (type D) may be a seep or an *in situ* oil (see Fig.5).

SEEP TYPE A

ORDOVICIAN GORDON GP SOURCE

The first seep type is found as coastal bitumens and at Johnson's Well on Bruny Island.

The ratios of the two C₂₇ hopanes suggest that all of the coastal bitumens were generated at closely similar thermal maturities of about 0.6-0.7 R_o. Geochemically, the Johnson's Well sample and the bitumens are very similar, although not identical, to the Ordovician Gordon Gp limestones (see Fig.7), and are characterised by abundant diasteranes (suggesting a clay-rich source), a predominance of C₂₇ steranes (typical of an algal source), and slightly lesser peaks for C₂₈ and C₂₉ steranes. Similar sterane ratios have been found in carbonate-derived oil from the Middle East and from Ordovician sedimentary rock found on mainland Australia (Volkman, in Bendall *et al* 1991, pp.78-79).

There is no geochemical similarity between this source/seep type and tasmanite, Gippsland crudes and the botryococcane-rich South Australian bitumens. However, the absence of methylhopanes is evidence against a shallow carbonate environment source.

Other possibilities for the source are the as-yet-unanalysed Proterozoic siltstones and Cambrian shales, the deep-water shales of the Ordovician (as at Surprise Bay on the South coast of Tasmania) or the Ordovician -Devonian Mathinna Gp shales.

SEEP TYPE B

BRIDGEWATER AND TUNNACK

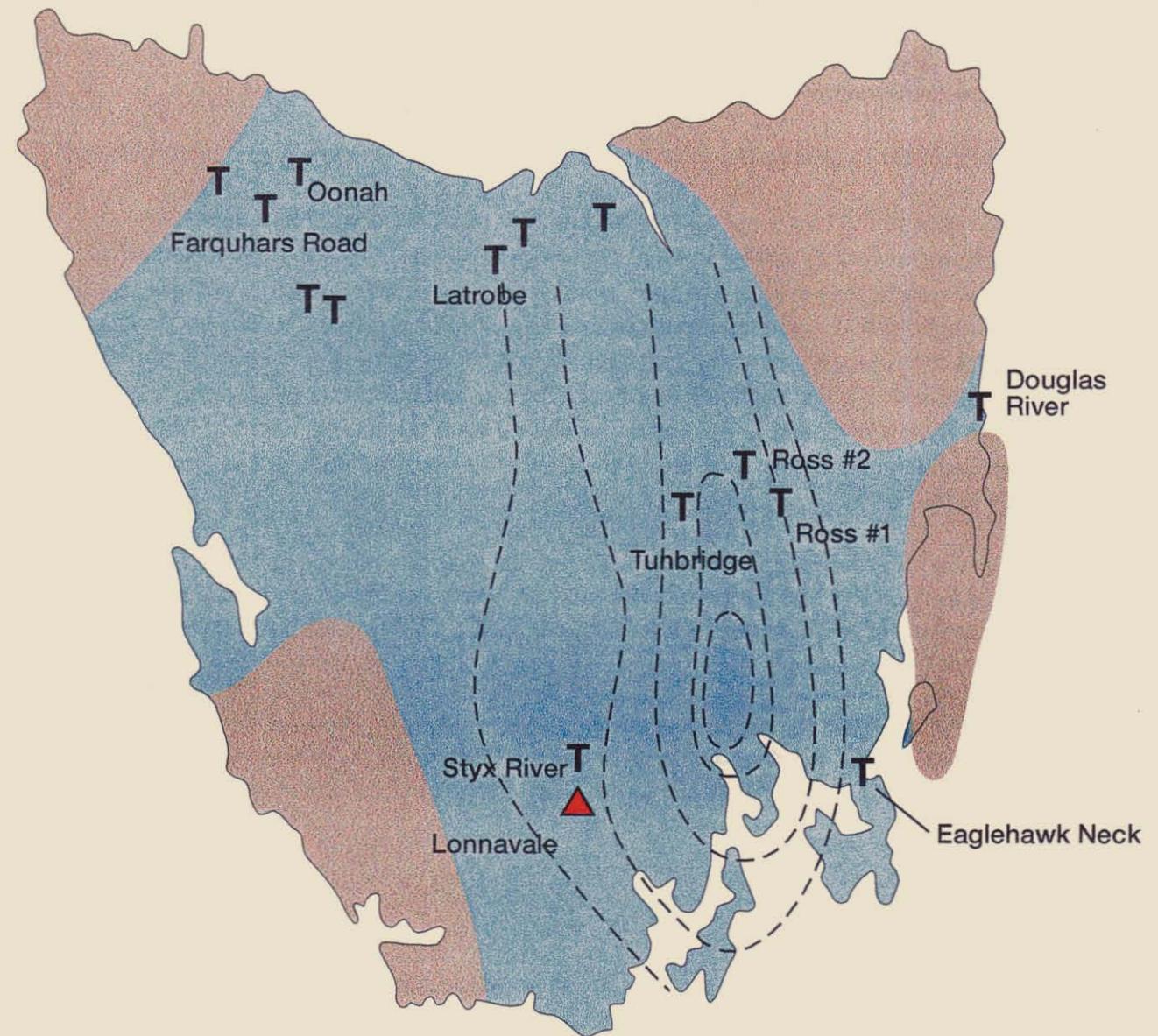
The second seep signature has been found in samples from five locations in southern Tasmania (e.g. Tunnack, south Bruny Island, Bridgewater) and is characterised by abundant C₂₉ steranes with C₂₇ and C₂₈ in equal amounts, with the major hopane being C₃₀, slightly more abundant than C₂₉. (Volkman and Holdworth, 1989a; Volkman and O'Leary, 1990). The samples are geochemically quite different to modern bitumens used for road making and this seep type has not, as yet, been matched to a known source rock.

One possible candidate is the Permian Preolenna Coal. The Preolenna Coal is developed as thin seams within the Liffey Gp in northern Tasmania (see Fig.3d), has high TOCs (av.=25%) and is oil prone terrestrial kerogen TypeII/III

"...not unlike the source for many of Australia's non-marine oils."
(Powell, 1985).

The Preolenna Coal has not, however, been geochemically analysed in detail.

Distribution of Tasmanite Oil Shale and abundant *Tasmanites* horizons plus Lonnavale seep



 Lonnavale seep

T Tasmanite oil shale and abundant *Tasmanites*

 Generalised isopachs for Lower Permian define Tasmanian Basin

0 50 km
0 30 miles

5 cm

SEEP TYPE C

QUAMBY/WOODY ISLAND FMS (INCLUDING TASMANITE OIL SHALE) SOURCE AND SEEP

The third seep type has been found at one location in Tasmania, at Lonnavale (near Glen Huon in southern Tasmania)(see Figs. 5, 6) and has the characteristic tricyclic triterpane signature of the Tasmanite Oil Shale (Revill *et al*, 1994).

This very organic-rich potential source rock (up to 28% TOC) is interbedded with generally lower (but still good) TOC shales in the Quamby Fm (the Woody Island Fm in the south) and correlates and is now known to be in the oil window over much of the basin.

The Tasmanite kerogen is Type I (oil prone) whilst the kerogen from the non-Tasmanite shales is type III (gas prone) (Banks *et al*, 1989). *In situ* reserves in the northern part of the state have been estimated at 43 million tonnes with a possible oil yield of 6 gigalitres (Banks *et al*, 1989). Similar figures may be calculated for the past oil production from the tasmanite within the deeper parts of the Tasmanian Basin where the oil shale is and was in the oil window.

An oil shale (consisting of the rock type tasmanite) is identified where the concentration of *Tasmanites* spores exceeds 10%. The geochemistry of the oil shale has been studied in detail by Baillie, (1987) and Revill *et al* (1994). In the north of the state, the main tasmanite seam is 1.57m thick and is sometimes associated with a subsidiary and thinner seam (James, 1950, p.9). The shale yields from 165 to 205 litres/tonne (Raphael & Saxby, 1980).

Tasmanites-abundant shale has now been recognised in several areas, including Farquhar's Road in NW Tasmania (Domack *et al*, 1993), the Douglas River on the east coast, (Revill *et al*, 1994), Eaglehawk Neck (Clarke, 1989 *in* Burrett and Martin, 1989) and in the Tunbridge, Ross #1 and Ross #2 boreholes in central Tasmania (Domack *et al*, 1993)(see Fig.6).

Domack *et al* (1993) and Campbell (1992) have analysed the TOC of the Quamby Fm in the Douglas River and the Ross #1 and Ross #2 boreholes. They found that most samples have a better than *fair* TOC (0.5-1.0), and that half of the samples of each section have a *good* TOC (between 1 and 2).

"Maximum TOC is associated with intervals of *Tasmanites* in cores both with levels of greater than 20% TOC found within the tasmanite in Douglas River, 17% in Ross #2 and greater than 2% in the *Tasmanites* zone in Ross #1 and Tunbridge" (Domack *et al*, 1993, p.478).

Thus in both the Ross #1 borehole and at Douglas River there is 56m of good source rock and in Ross #2 there is 125m of good and about 30m of fair source rock.

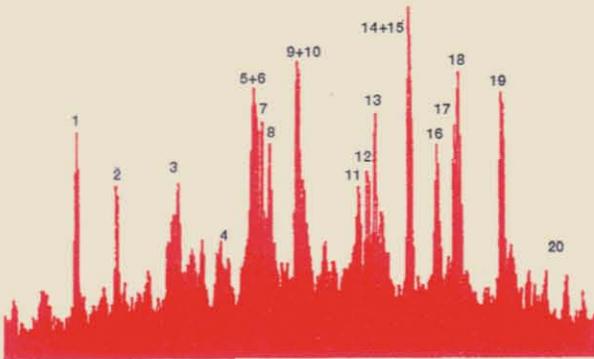
One band 0.37m thick occurs within the Woody Island Fm in the Styx River area near Maydena (BHP, 1981,1982) where it yields 6 litres per tonne. BHP analysed numerous samples from two borehole sections through 200m of the Woody Island Fm and found average yields of oil of about 2 litres per tonne with some samples yielding

Seeps and Probable Source Rocks

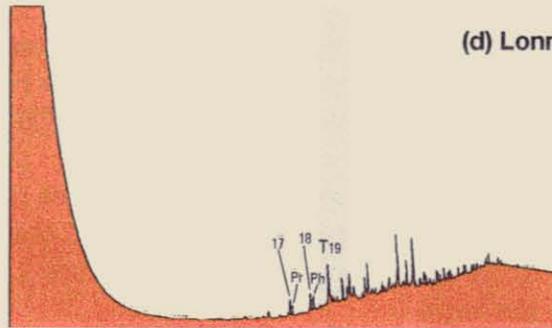
Gordon Gp. signature

Tamanite Oil Shale signature

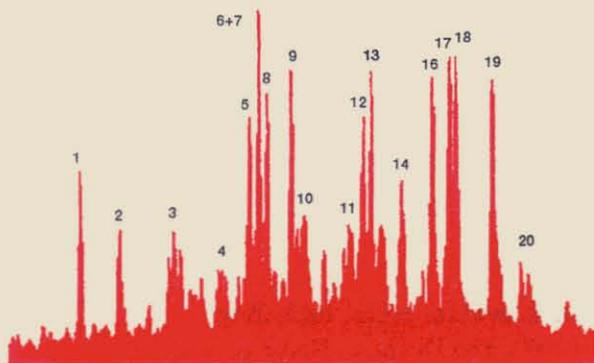
(a) Johnsons Well



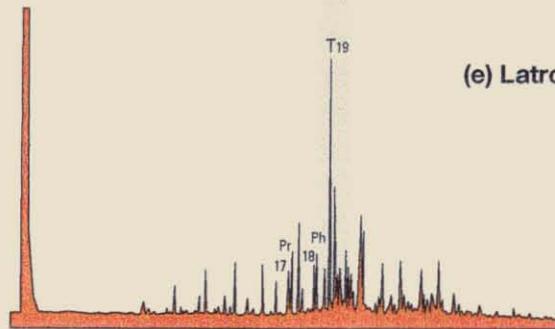
(d) Lonnavele



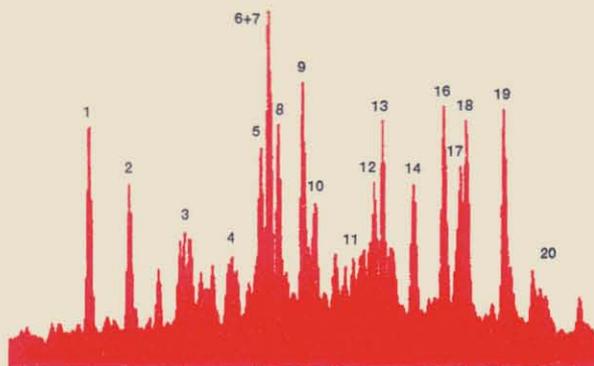
(b) Ida Bay Limestone



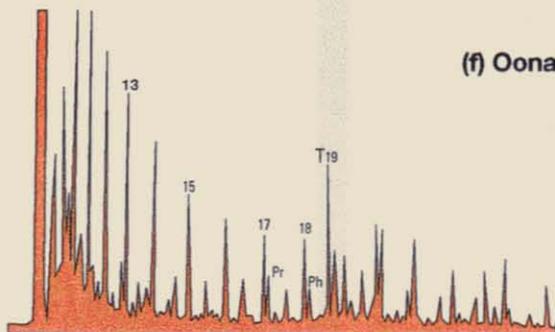
(e) Latrobe



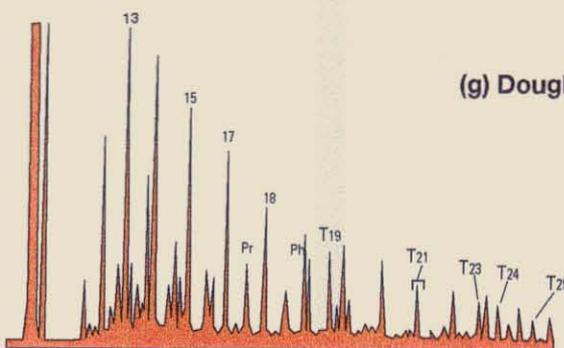
(c) Deep Creek Bitumen



(f) Oonah



(g) Douglas River



(m/z 217 Steranes and diasteranes)

(triterpanes)

Figure 7

up to 7 litres per tonne. They concluded that the Woody Island Fm
 "...may have served as an oil source rock in the past." (BHP, 1982, p.6).

In 1995 an oil seep was found within unusually strongly fractured Jurassic dolerite by Dr Ralph Bottrill of the Tasmanian Mines Department, about 15 km south of the Styx River locality at Lonnvale near Glen Huon. Dr Bottrill's samples were analysed by Dr A. Revill of the CSIRO (Revill, 1996).

Dr S. Wythe of AMDEL came to very similar conclusions as Revill based on samples collected by the writer. Wythe and Watson (1996) concluded that the Lonnvale seep is a lightly biodegraded, low sulphur, heavy crude that has undergone some migration from its source area. It is clearly derived from an anoxic shale rich in *Tasmanites*. Geochemical markers show that the seep derives from a source with a R_o of 0.8 equivalence (i.e. the middle of the oil window) (see Fig. 7).

SEEP TYPE D

POATINA

A sample of a Lower Permian mudstone from Poatina, in central Tasmania, contains n-alkanes and low molecular weight aromatics characteristic of a mature crude petroleum (Volkman and Holdsworth, 1989b). Methyl hopanes are very minor constituents (thereby excluding a carbonate source) and diasteranes, which are typical of a clay rich source, are abundant.

The methyl-phananthrene ratio and the aliphatic biomarkers suggest the petroleum was generated at a R_o equivalence of 0.75 (i.e. well into the oil window) and the presence of low abundances of tricyclic alkanes suggest that *Tasmanites* may have been a partial source. However, other n-alkanes are more abundant suggesting that the source is not rich in *Tasmanites* spores. This sample may be indigenous oil and perhaps this is the signature of the mainly gas-prone shales of the Quamby/Woody Island Fms.

OIL IN SHITTIM #1

Water samples, with an unusual lime green colour, from a swab at 1635m associated with elevated gas C_1 - C_8 values reveal traces of an oil with a high pristane-phytane ratio (Whyte 1996). A high pristane-phytane ratio usually suggests a higher land plant origin. This oil, presumably sourced from the Permian or younger has probably migrated in laterally or from below along with the wet gas.

Legend for Figure 7

Ordovician		Permian	
a	trace seep at Johnson's Well	d	heavy crude seep, Lonnvale
b	Ordovician Gordon Gp limestone, Ida Bay	e	Tasmanite Oil Shale, Latrobe
c	coastal tar from Deep Ck, nr Port Davey, SW Tasmania	f	Tasmanite Oil Shale, Oonah
		g	<i>Tasmanites</i> rich horizon, Douglas R. borehole, near Bicheno,

Shittim #1 well log, North Bruny Island

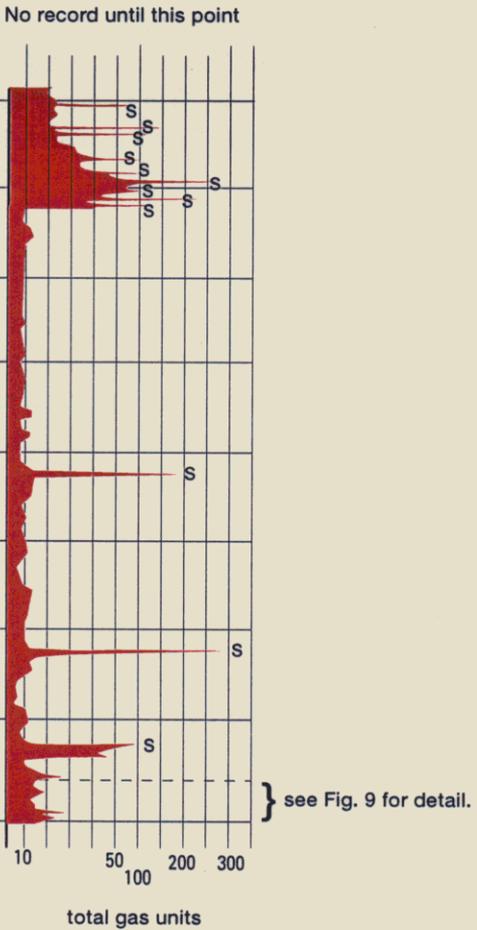
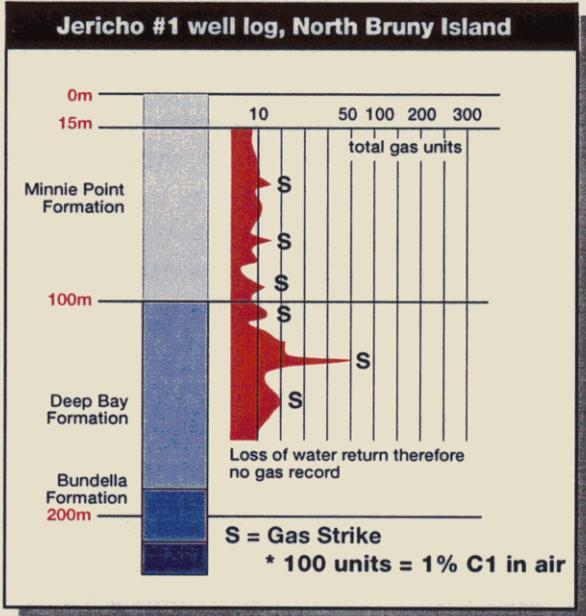
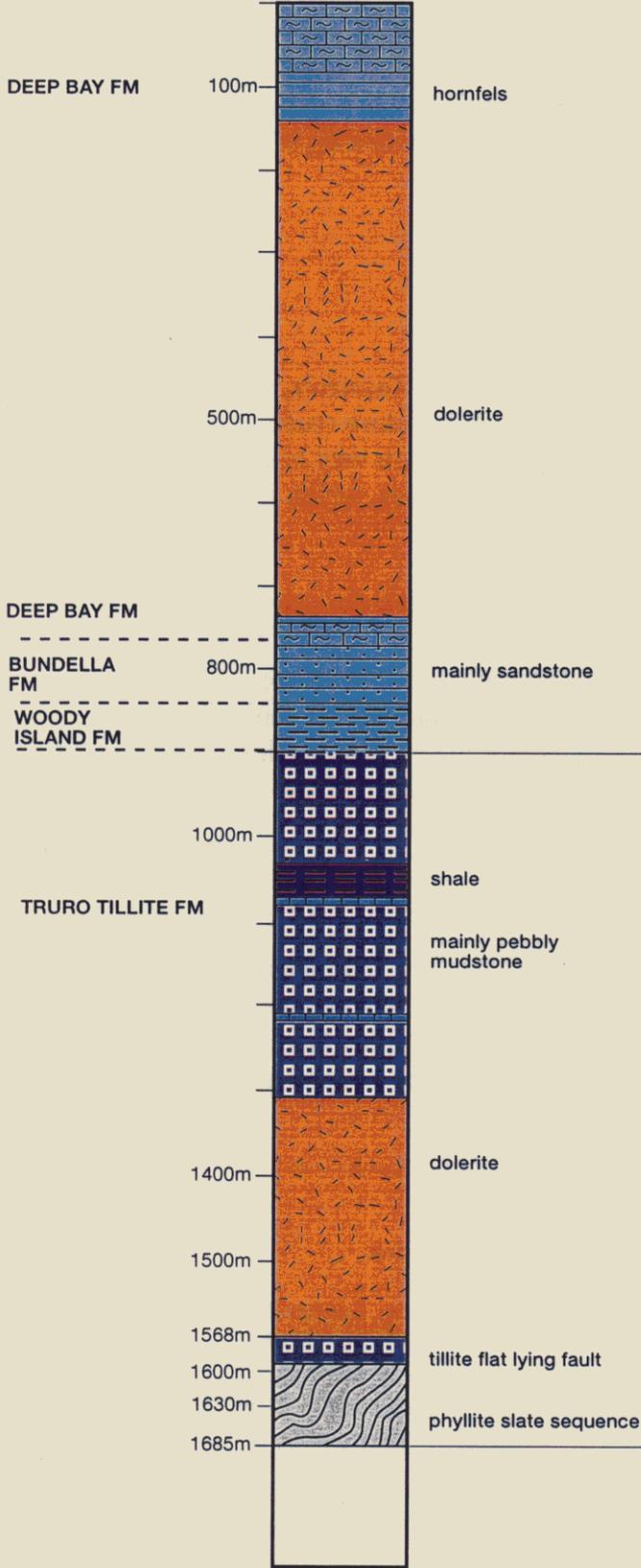


Figure 8

Natural Gas

Gas has been reported at several locations in Tasmania. For example, methane from Kimberley is of bacterial (biogenic) origin whereas methane from Smithton is of thermogenic origin (Baillie, 1992).

Gas encountered in the recent stratigraphic hole on Bruny Island (see Fig.8) has been analysed by the Central Science Laboratory at the University of Tasmania (Davies, 1995,1996) and by Cass at AMDEL (Cass, 1996). Hydrocarbons were found to be methane with a small amount of ethane (approx 25 ppm). The carbon isotope composition of the methane at $-50.10/00$ PDB places it firmly in the middle of the "gas associated with oil generation" range (Feux, 1977).

Background methane readings ranged from a few hundred to a few thousand ppm. Higher levels associated with fractures were recorded with trip gas in the lower dolerite being 9000 ppm methane and 4 ppm ethane. Generally, background methane and ethane levels increased downwards through the lower sill and hydrogen decreased.

Gas increased from below the low angle fault at 1575m. Thirteen samples were collected from 1630m to 1686m and analysed by AMDEL (Valente, 1996,1997).

Because of the presence of highly reactive hydrogen it is difficult to be sure of oxygen-based correction to the gas values. Thus the air-corrected values quoted here are likely to be minimum values.

These analyses show an air-corrected increase in nitrogen, decrease in hydrogen and a decrease in carbon dioxide to zero (Figs. 9,11). Helium increases from zero to an air-corrected value of 1.62%. Most importantly C_3-C_8 are detected in significant levels for the first time and total C_2-C_8 increase from 1630m to 1686m.

A histogram of the $C_2:C_3$ ratios shows that the gas has a range and a mode very similar to "gases from oil and gas provinces" (Fig. 10) and is unlike that from "non-associated" gases (Nikonov, in North 1985, p29). The source of the C_1-C_8 gas is unknown but may be migrating in laterally or from depth.

Helium

Helium is present in eight of the samples and ranges from air-corrected values of 0 to 1.62%. Four of the samples are greater than the economic cut-off value of 0.3%. A sample from 1680m contains 0.18% (air-uncorrected) and 42% (air and nitrogen corrected).

These results strongly suggest the possibility of economic quantities of helium on Bruny Island.

Variations in air corrected gas content in Shittim #1

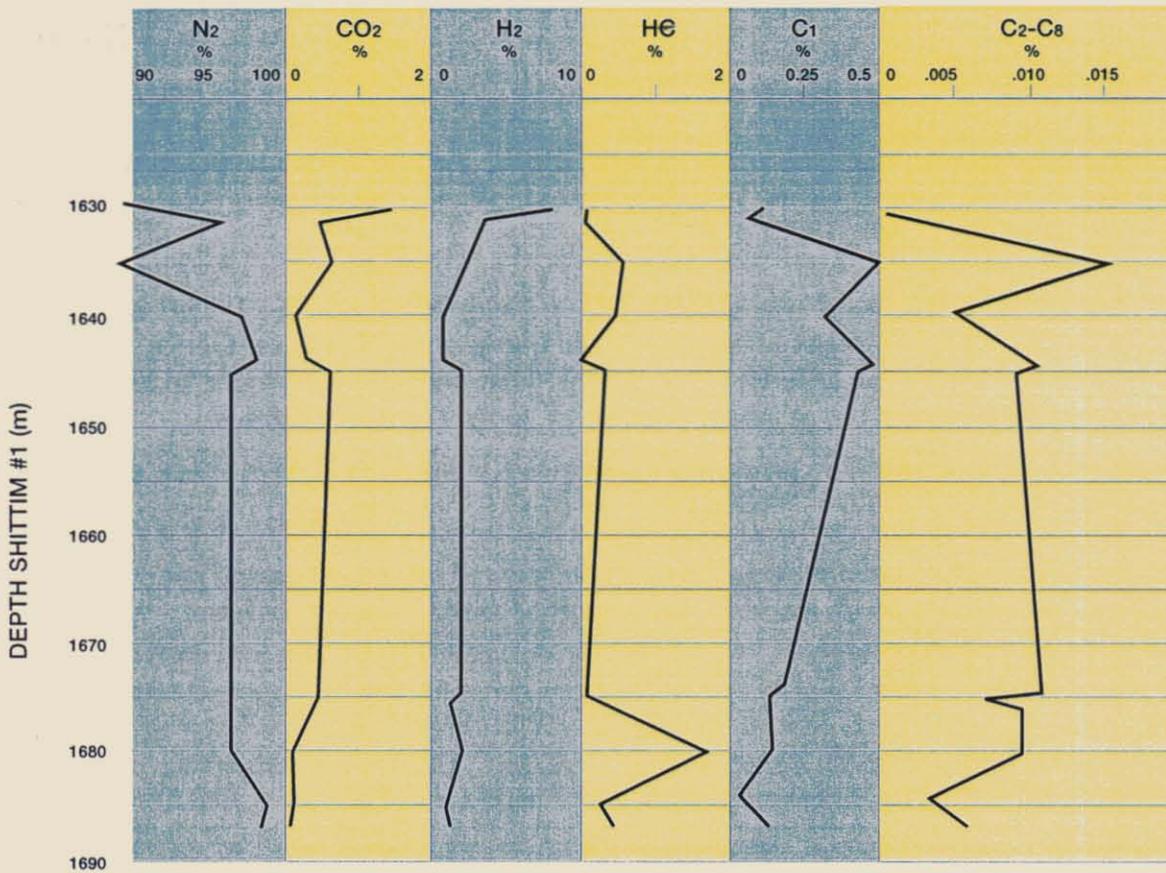


Figure 9

Natural gas analyses compared to analyses from Shittim #1 (from Nikinov in North, 1985)

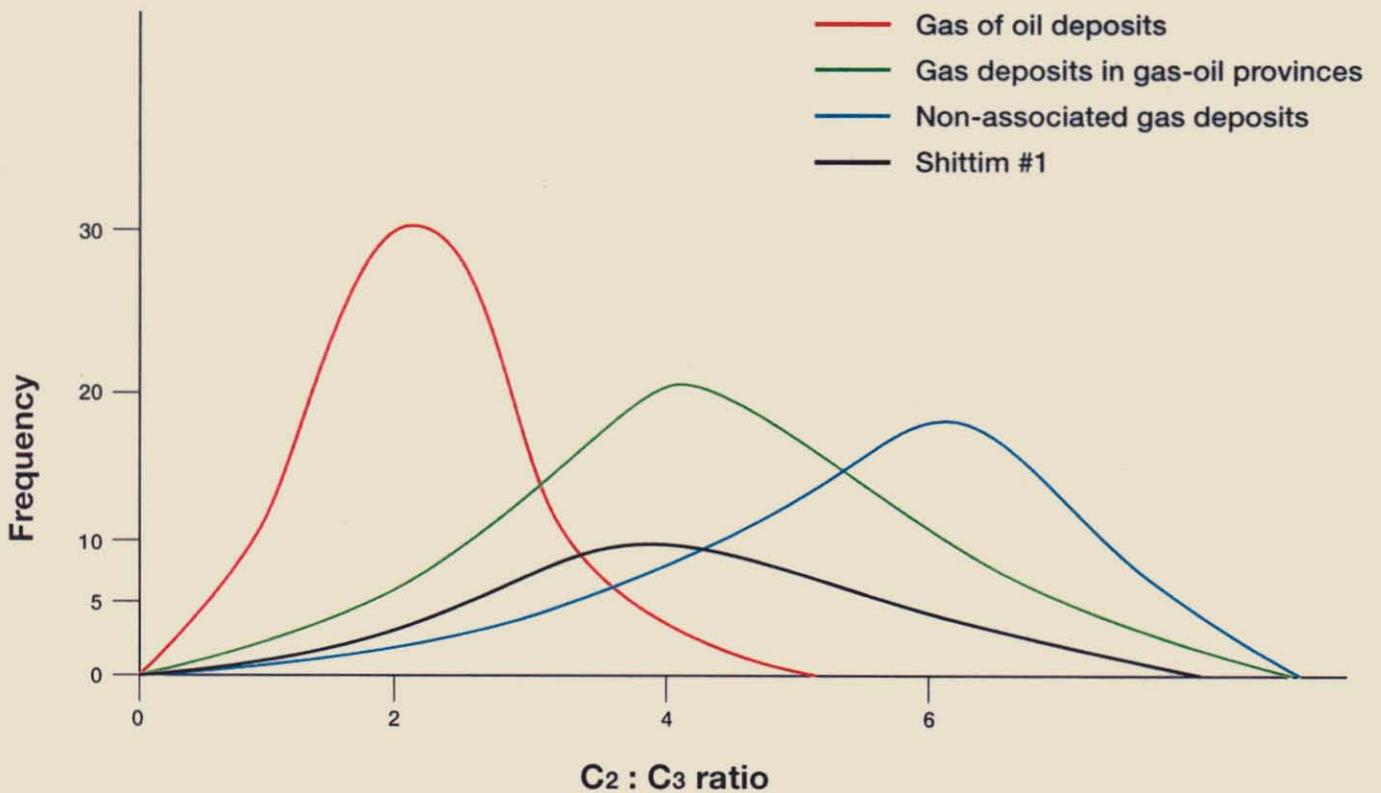


Figure 10

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Shittim 1C Gas Results (air, nitrogen - CO₂ corrected)

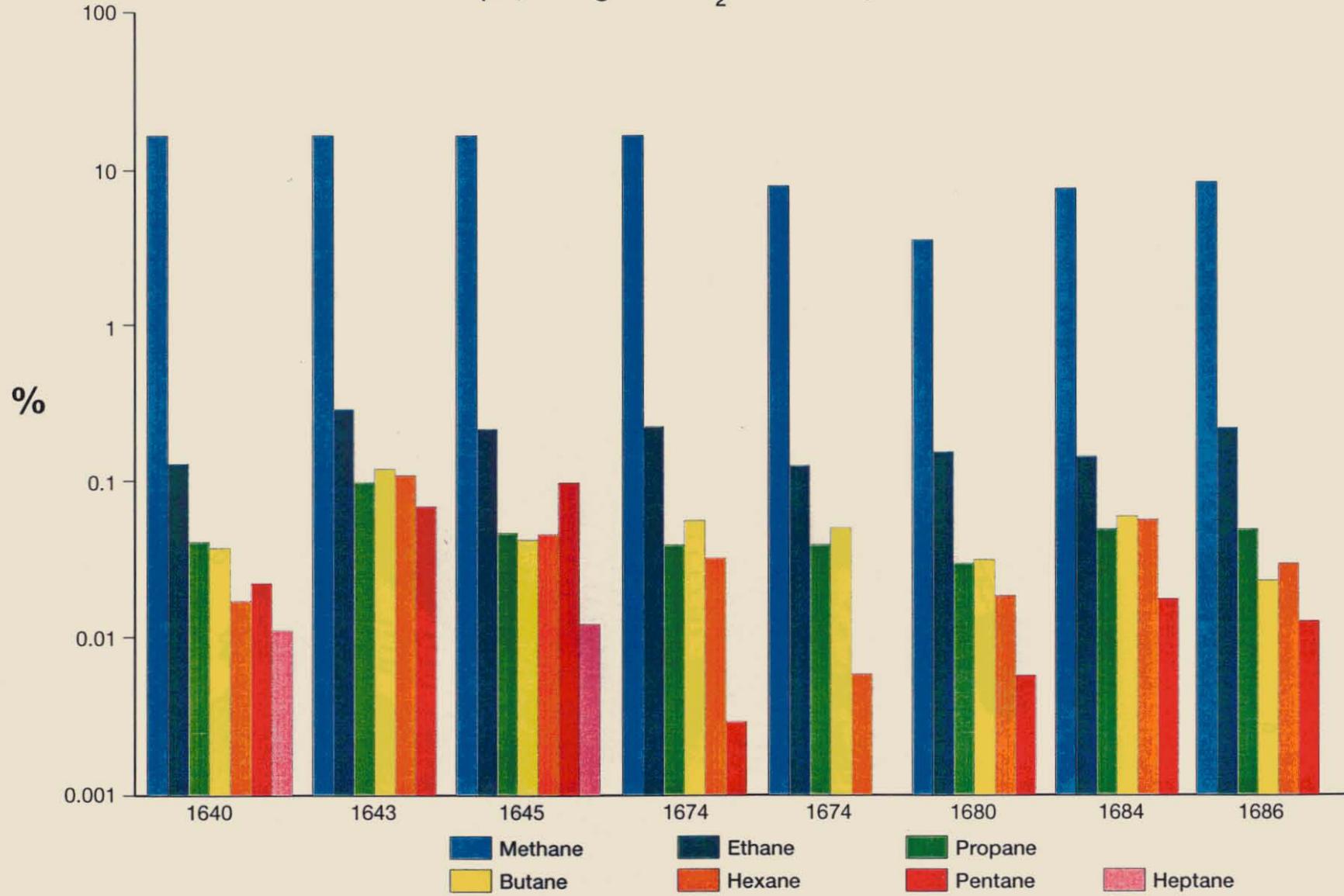


Figure 11

Summary of Vitrinite Equivalent and Vitrinite Measurements on Lower Permian Super Gp. Rocks

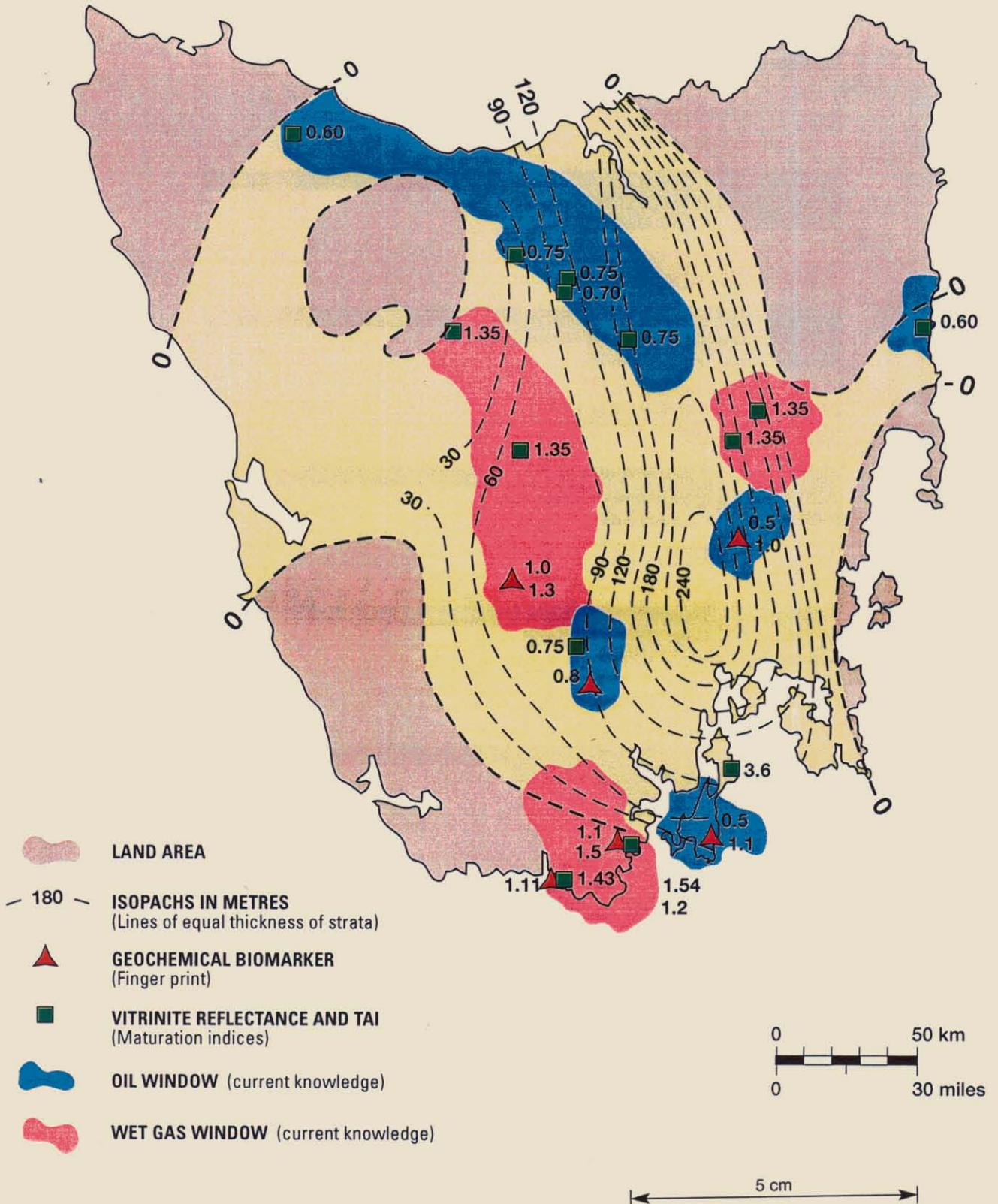


Figure 12

Maturation

Gordon Gp carbonates

A study of conodont color alteration indices (CAI) shows that the Gordon Gp limestones are overmature in western Tasmania but are in the oil and gas windows in central and southern Tasmania (Burrett, 1992). Oily residues and a petroliferous odour have commonly been reported by geologists (Prof. S.W. Carey *pers. comm.*) and paleontologists (Dr J. Laurie *pers. comm.*) studying the Gordon Gp carbonates in central Tasmania.

The common presence of pyrobitumens in vugs in the Eldon Gp sandstones of Zeehan in western Tasmania has been interpreted as oil generated from the Gordon Gp and destroyed *in situ* during the Devonian Tabberaberan orogeny. However, oil collected from Queenstown, in western Tasmania, where the Gordon Gp Limestones have a high CAI (more than 300°C) has a much lower vitrinite equivalence (Volkman, *in* Bendall *et al.*, 1991).

This could be explained by juxtaposition of thrust slices with different maturities during the Tabberaberan orogeny. The Gordon Gp limestones almost certainly produced hydrocarbons and under parts of the Tasmanian Basin they are very probably in the oil and gas windows. They may well be the source of the wet gas in the Bruny Island hole. Because of the fold/thrust nature of the sub-Parmeener, such Gordon Gp subcrops may be difficult to locate (see Fig.2).

Lower Parmeener Supergroup (including Tasmanite Oil Shale)

Several organic maturation indices are available for the Upper Carboniferous-Permian Lower Parmeener Supergroup. These are based on vitrinite reflectance, TAI and geochemical parameters and all available data is summarised as vitrinite reflectance (R_o) equivalent values in Fig.12 (from Burrett & Bendall, 1996) and in Table I.

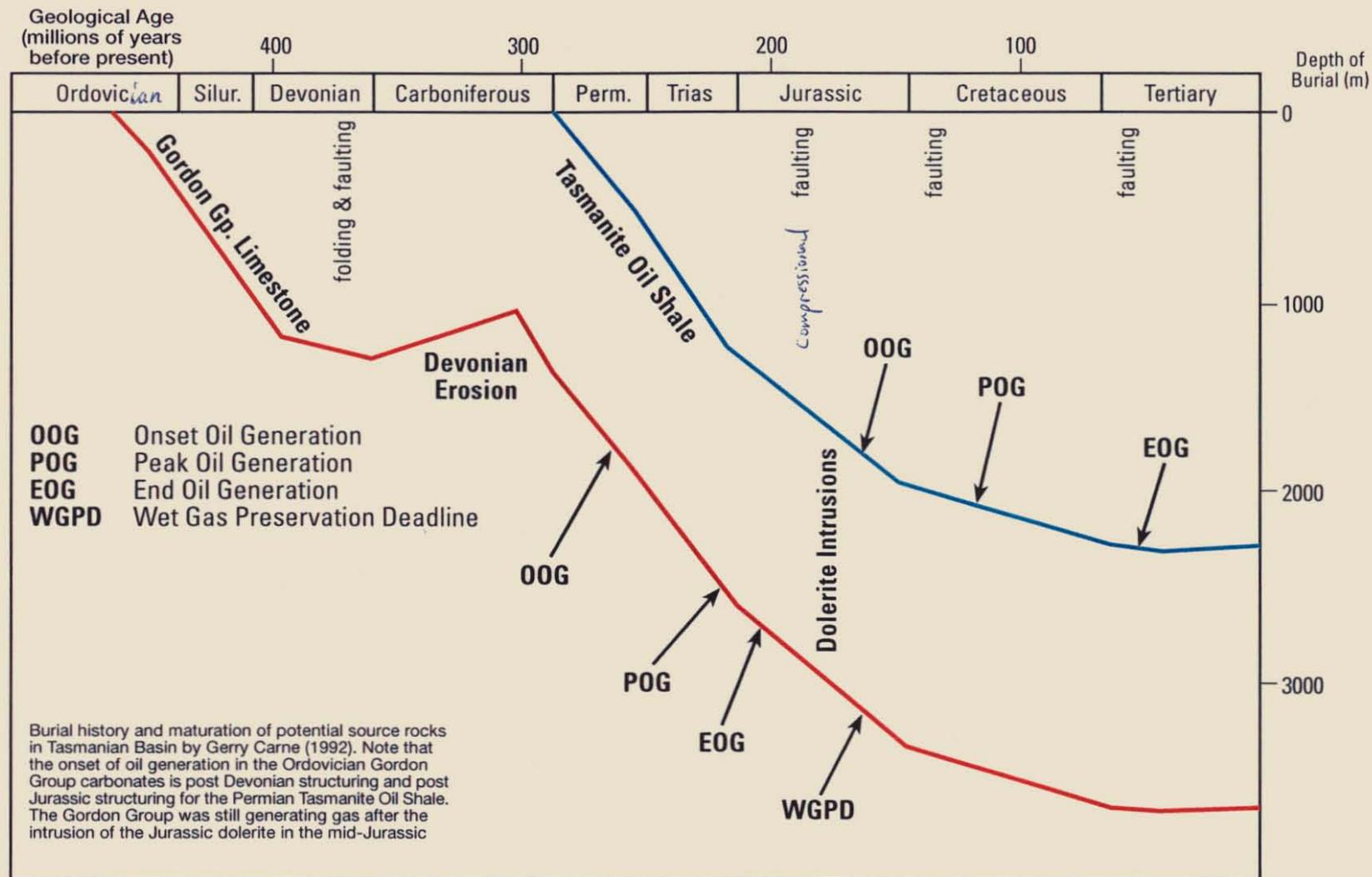
The oil window R_o ranges from about 0.5 to about 1.25 (Hunt, 1979, p.344) with maximum oil generation occurring at about 0.8. North (1985, p.65) takes the onset of oil generation as $R_o = 0.65$, and end of oil generation as $R_o = 1.35$. These values are used herein.

The wet gas window R_o ranges from 0.65 to 2 and the dry gas limit has an R_o of about 3.9.

Almost all Lower Parmeener Supergroup Tasmanian Basin values are in excess of 0.5 (Table 1). Such values are not surprising in the depocentre of the basin, as such R_o values would be expected with an overburden of 2km and a normal geothermal gradient (Hunt, 1979, p.344).

Two kilometers of overburden and an R_o of 0.6 on the Woody Island/Quamby Fms would be achieved by average thicknesses of Lower Parmeener (700m), Upper Parmeener (500m), dolerite (300m) and Tertiary (500m) (Table II).

Thermal Maturation Estimate for Paleozoic Successions in Tasmania (from Carne 1992)



Maturation Modelling

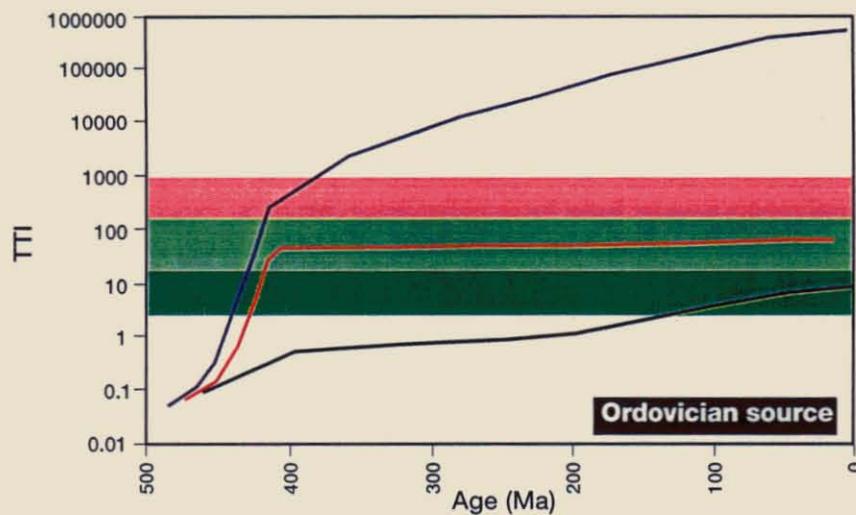
Several geologists have attempted maturation modelling of the putative source rocks in the Tasmanian Basin assuming various ranges of paleogeothermal gradients and depths of burial (e.g. Carne, 1992; Woods, 1995) (see Figs. 13,14,15). Carne (1992) showed that with the Gordon Gp the onset of oil generation was in the Permian with the end of wet gas generation in the mid-Jurassic.

A more intensive study by Woods (1995) using Lopatin diagrams (see Figs.14, 15) shows that the base of the Gordon Gp passed through the oil generation window in the Silurian and Early Devonian when maximum burial is assumed (the west coast situation mentioned above) and may well have been generating oil in the Cretaceous and Tertiary if minimum burial is assumed (as suggested by conodont CAI's from central and southern Tasmania). On one scenario of burial/geothermal history, gas generation may have started in the Cretaceous and continued through the Tertiary.

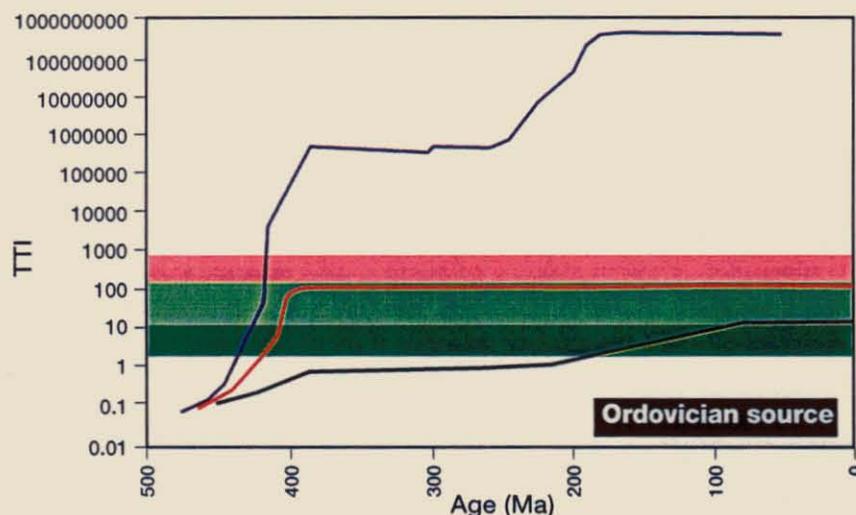
Simple modelling (see Fig.14) of the Quamby Fm /Woody Island Fm, including the Tasmanite Oil Shale, suggests onset of oil generation in the Late Jurassic and end of oil generation in the Early Tertiary (Carne, 1992). Gas generation would continue through the Tertiary. Modelling by Woods (1995) suggests a range of timing of onset of oil generation from the Early Triassic through to the Quaternary (see Fig.15).

Problems with these models are the estimation of paleogeothermal gradients and the estimation of overburden thickness. Recent work on fission tracks suggests that there has been a surprising amount of uplift in the Cretaceous and that parts of Tasmania may have been more deeply buried than previously thought (Hill *et al*, 1995).

Thermal Maturities



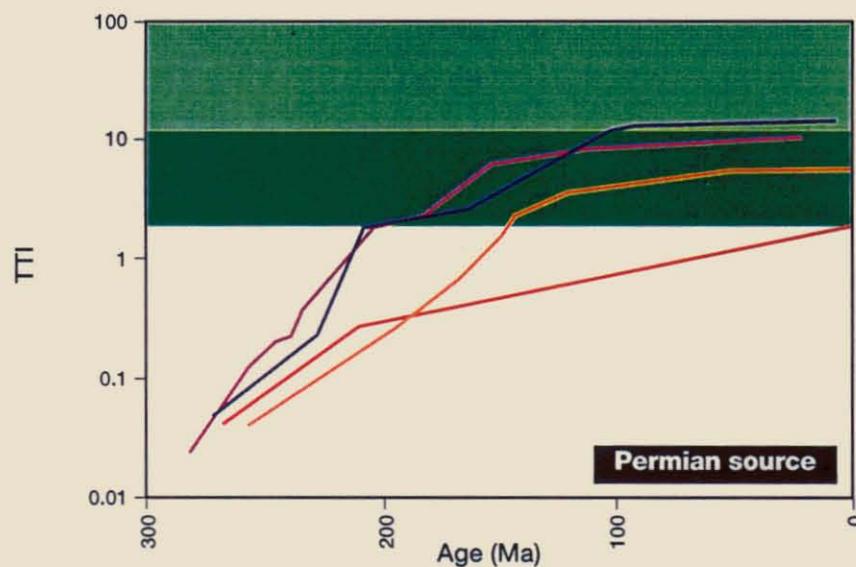
Thermal maturity versus time for the base of the Gordon Limestone. Simple geothermal history.



Thermal maturity versus time for the base of the Gordon Limestone. Maximum interpreted geothermal history.

- minimum burial
- intermediate burial
- maximum burial
- Gas Generation
- Oil Generation
- Oil generation from S-rich kerogen

Figure 14



Thermal maturity versus time for the base of the Woody Island Formation using various heating and burial scenarios. Illustrating the timing of oil generation from sulphur-rich kerogen and the conventional 'oil window' from Woods 1995.

- minimum burial and geothermal history
- minimum burial, complex geothermal history
- maximum burial, simple geothermal history
- maximum burial and geothermal history
- Oil Generation
- Oil generation from S-rich kerogen

Figure 15

Liffey/Faulkner Group across the "Tasmania Basin"

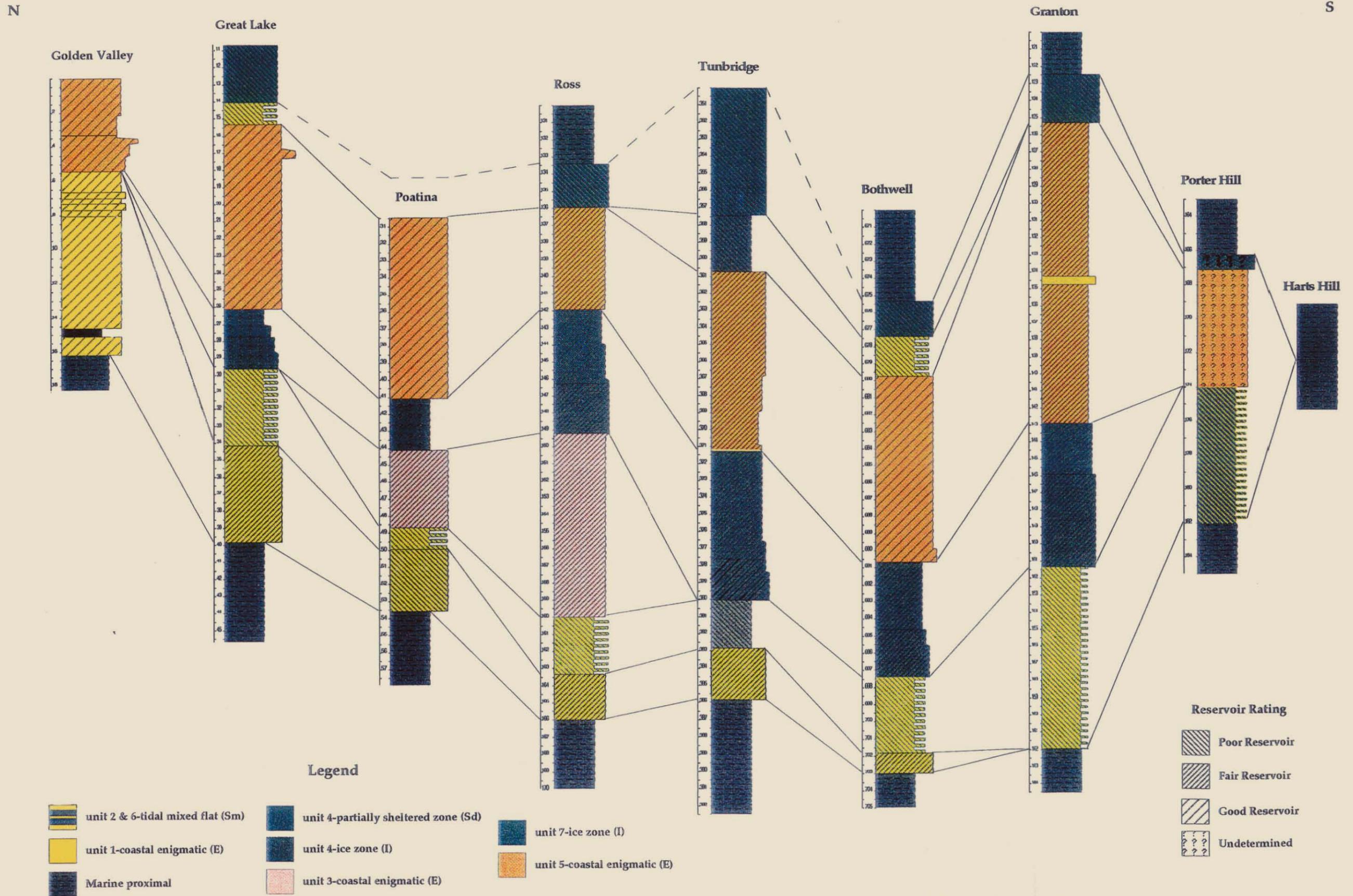


Figure 16: Reservoir rating of the Liffey/Faulkner Group

Potential Reservoirs, Seals and Traps

Reservoirs

Possible reservoirs occur in the Ordovician Gordon Gp limestones (as reefs and as paleokarst), in the siliciclastics of the Siluro-Devonian Eldon Gp (or Tiger Range Gp) and in the sandstones of the Triassic. However, the most likely reservoir is the 'lower freshwater sequence' comprising the Liffey and Faulkner Gps.

This thick (up to 100m) mid-Permian glaci-fluvial to marginal coastal sequence of sandstones and siltstones was deposited during a minor marine regression with an influx of sands from the north, east and west (Martini and Banks, 1989). There is a pronounced thinning towards the south of the Basin where it interdigitates with the mainly marine Bundella Fm. Only the marine Bundella Fm is found in the Shittim #1 stratigraphic hole on Bruny Island, where a pronounced gas show was reported and where (although contact metamorphosed) the porosity ranges from 11-12% and with corresponding horizontal permeabilities of 6.8 and 9.0 mdarcy.

The percentage of fluviatile sandstones within the Liffey Gp increases from Bruny Island towards the north (see Figs.3d, 16). In a detailed study Maynard (1996) has shown that the 'coastal enigmatic' facies of Martini and Banks (1989) has especially good oil-reservoir potential. Overall Maynard (1996) has shown that several corehole sections have up to 35m thickness of fair to good reservoir (see Fig.16).

The glaci-fluvial sandstones of the Liffey and Faulkner Gps are comparable environmentally and compositionally to the glaci-fluvial Permo-Carboniferous reservoir sandstones of the producing Gondwana basins of Oman, South America and the Cooper Basin (Maynard, 1996, Chapter 6; Potter *et al*, 1995).

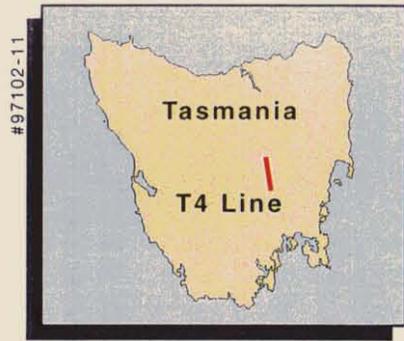
Seals

Much of the Lower Parmeener Supergroup consists of poorly sorted siltstones and indurated mudstones. These have low intrinsic porosity and permeability and, except where intensely fractured, would make good seals.

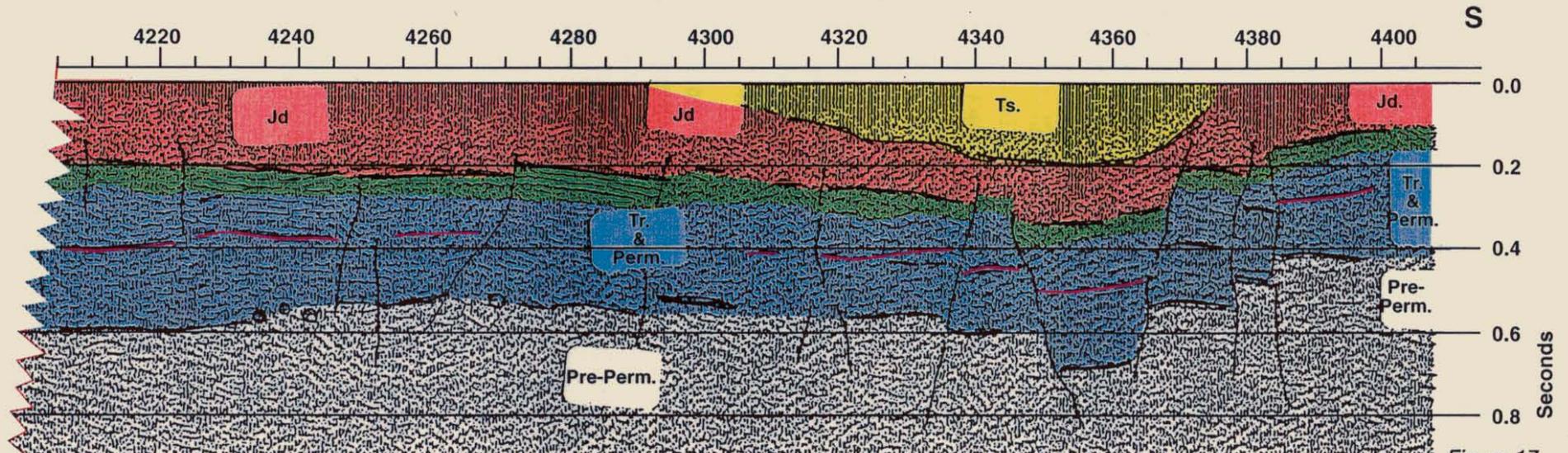
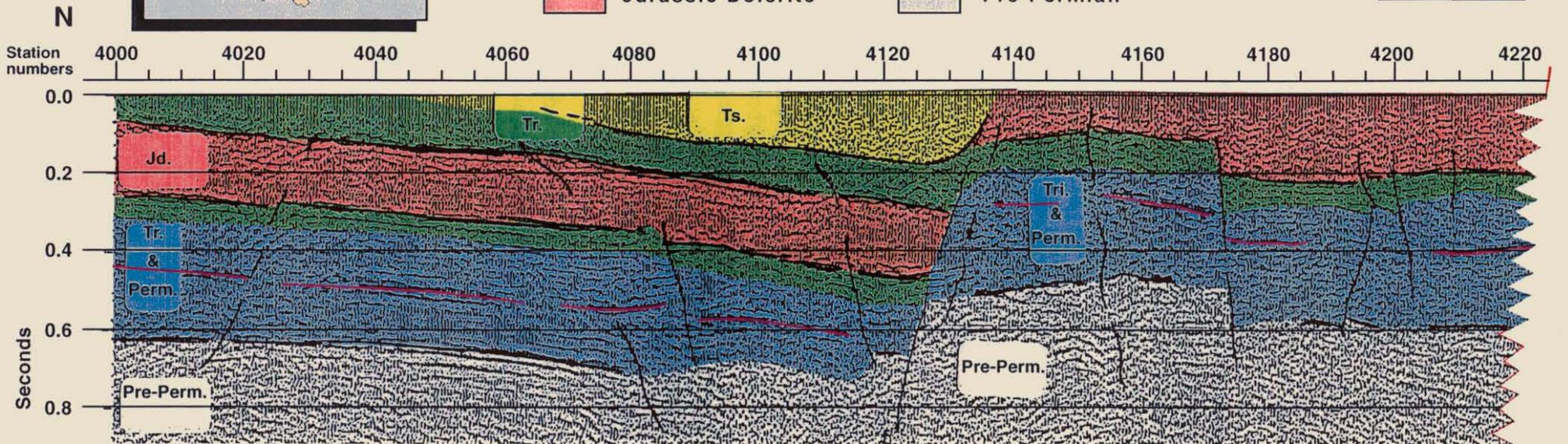
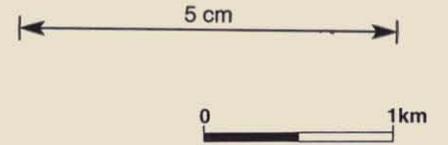
Similarly the extensive and thick sills of Jurassic dolerite are also effective seals. These dolerite sheets have frequently metamorphosed the Parmeener sedimentary rocks to a hornfels which has an even lower porosity, except near the surface where weathering has preferentially removed calcareous shells.

Traps

Potential fold traps within the fold/thrusted Lower-Middle Paleozoics are many but their identification beneath the Tabberaberan unconformity is difficult. A short seismic line at Clifton Beach has revealed some folding in the older Paleozoics.



Interpretation of AGSO Seismic Line T4 (1995)



(Raw data reproduced with kind permission of AGSO - Interpretation by Leaman, for Great South Land Minerals P/L, 1996)

Figure 17

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unconformably beneath the Permo-Carboniferous Lower Parmeener Supergroup (Leaman, 1987).

Structures within the Parmeener Supergroup are mainly extensional faults. These are easily recognised on the AGSO seismic line (see Fig. 17).

Berry and Banks (1985) recognise two phases of faulting within the Parmeener Supergroup. An earlier Mesozoic compressional phase was followed by an early Tertiary extensional phase. The compressional faulting phase may have occurred in the late Jurassic and/or Cretaceous and would have been roughly synchronous with peak oil generation and prior to gas generation from the Tasmanite Oil Shale.

It is well known that the Lower Parmeener is folded into gentle anticlines and synclines are well known near Maydena and several domal structures have been identified by field mapping such as those at Hunterston and Sorell. Seismic surveys across these domes are necessary in order to exclude the possibility of lopolith control, however unlikely that may be.

The most common type of trap is therefore likely to be a fault trap with minor traps based on domal structures within the Lower Parmeener.

Stratigraphic traps due to a pinch-out of Liffey Gp reservoir sandstones are also possible. Leaman (1995) has identified a reflector within the Lower Parmeener as the Liffey Gp (= 'lower freshwater sequence' on Fig. 17) and this is discontinuous on the seismic section, perhaps due to pinch-out.

Conclusions

Two valid plays are represented in the Paleozoics. One is a source in the Ordovician Gordon Gp limestones reservoired in the Gordon/Eldon Gps or the Parmeener Supergroup. The wet gas found at Bruny Island may be part of this play. The second play is intra-Parmeener.

Matching of sources to seeps within the Tasmanian Basin suggests that the Gordon Gp carbonates and at least two horizons within the Lower Parmeener Supergroup are potential source rocks.

The widespread and extremely TOC-rich Tasmanite Oil Shale is an ideal source and has produced a migrated, low sulfur heavy crude seep near Glen Huon in southern Tasmania. Thermal maturation modelling and empirical data from outcrop and subcrop maturation indices suggests that the Tasmanite Oil Shale would have produced oil and gas both prior to and post deformation during the Jurassic, Cretaceous and early Tertiary.

Recent acquisition of seismic data by AGSO shows that ubiquitous dolerite sills are not impediments to seismic prospecting in the Tasmanian Basin. The AGSO seismic line shows that, contrary to most previous experience, both the upper and lower surfaces of the dolerite sill yield reflections and that structures and individual horizons within the Parmeener Supergroup, including the potential reservoir of the Liffey-Faulkner Gps, may be easily recognised.

Leaman (1987) has shown that structures beneath the Tabberaberan (mid-Devonian) unconformity can be discerned if the seismic acquisition parameters and processing are optimised. Thus, while the intra-Parmeener play concept is easier to plan an exploration program around, the older play of the Gordon Gp source and reservoir should not be discounted.

Tables and References

TABLE I

Maturity Indices of rocks and coastal tars in and around the Tasmanian Basin

Rock Type	Age	Locality	Method	R _o equiv.	Maturity	Reference
oil (trace)	seep	Bruny Island		0.6-0.7	mature	Volkman 1987
mudstone with oil	in situ or seep Lwr Permian	Poatina	C27 hopane ratios	0.7	mature	Volkman & Holdsworth 1989
mudstone	Lwr Permian	Mersey R	TAI =3(brown)	1.0-2.0	very mature-gas	Summons 1981
mudstone	Lwr Permian	Bronte	TAI =3(brown)	1.0-2.0	very mature-gas	Summons 1981
siltstone (Woody Is)	Lwr Permian	Styx R	TAI=2(orange)	0.45-1.0	mature	Summons 1981
mudstone	Lwr Permian	Quamby Brook	TAI=2(orange)	0.45-1.0	mature	Summons 1981
mudstone	Lwr Permian	Poatina DDH5021 27m	TAI=2(orange)	0.45-1.0	mature	Summons 1981
mudstone	Lwr Permian	Poatina DDH5021 242m	TAI =3(brown)	1.0-2.0	mature	Summons 1981
Quamby/Woody Isl Fn	Lwr Permian	Preolenna	MP 1	0.6	mature	Bendall 1992
Quamby/Woody Isl Fn	Lwr Permian	Golden Valley	MP 1	0.7	mature	Bendall 1992
Quamby/Woody Isl Fn	Lwr Permian	Poatina	MP 1	0.75	mature	Bendall 1992
Quamby/Woody Isl Fn	Lwr Permian	Douglas R	MP 1	0.6	mature	Bendall 1992
Quamby/Woody Isl Fn	Lwr Permian	Ross #2	MP 1	1.35	gas	Bendall 1992
Quamby/Woody Isl Fn	Lwr Permian	Tunbridge	MP 1	1.35	gas	Bendall 1992
Quamby/Woody Isl Fn	Lwr Permian	Poatina	TAI=2	0.45-1.0	mature	Domack 1991, in Bendall 1992
Quamby/Woody Isl Fn	Lwr Permian	Tunbridge	TAI=3	1.0-2.0	very mature-gas	Domack 1991, in Bendall 1992
Quamby/Woody Isl Fn	Lwr Permian	Ross #1 & #2	TAI=3	1.0-2.0	very mature-gas	Domack 1991, in Bendall 1992
Quamby/Woody Isl Fn	Lwr Permian	Douglas R	TAI=2	0.45-1.0	mature	Domack 1991, in Bendall 1992
Tasmanite oil shale	Lwr Permian	Great Bend	C29	0.5	immature	Baillie 1987
Tasmanite oil shale	Lwr Permian	Mersey R	Vitrinite	0.4	immature	Russell, in Baillie 1987
bitumen	seep	Flinders Island	MPI/MPR	0.75	mature	Volkman & O'Leary 1990 (b)
bitumen	seep	Deep Ck	MPI/MPR	0.7	mature	Volkman & O'Leary 1990 (b)
bitumen	seep	Rocky Boat Hbr	MPI/MPR	0.74	mature	Volkman & O'Leary 1990 (b)
bitumen	seep	Surprise Bay	MPI/MPR	0.73	mature	Volkman & O'Leary 1990 (b)
bitumen	seep	Pt Hibbs	MPI/MPR	0.76	mature	Volkman & O'Leary 1990 (b)
bitumen	seep	King Island	MPI/MPR	0.75	mature	Volkman & O'Leary 1990 (b)
bitumen	seep	New R	MPI/MPR	0.71	mature	Volkman & O'Leary 1990 (b)
bitumen	seep	Marawah	MPI/MPR	0.77	mature	Volkman & O'Leary 1990 (b)
Florentine V Fn	Lwr Ordovician	Florentine Valley	MPI/MPR	1.0-1.3	very mature	Volkman & O'Leary 1990 (b)
brittle tar	seep	Bruny Island	MPI/MPR	0.5(+1.1)	mature	Volkman & O'Leary 1990 (b)
sandstone	seep	Tunnack	MPI/MPR	0.7(0.8)	mature	Volkman & O'Leary 1990 (b)
tasmanite oil shale	Lwr Permian	Oonah	MPI/MPR	"immature"	immature	Revill <i>et al</i> 1994
tasmanite oil shale	Lwr Permian	Douglas R	MPI/MPR	"mature"	mature	Revill <i>et al</i> 1994
Lwr freshwater sequence coal	mid Permian	Fingal	direct vitrinite	0.55	immature	Powell 1985
Preolenna coal	mid Permian	Relapse Ck	direct vitrinite	0.48	immature	Powell 1985
Preolenna coal	mid Permian	Relapse Ck	direct vitrinite	0.49	immature	Powell 1985
Preolenna coal	mid Permian	Relapse Ck	direct vitrinite	0.49	immature	Powell 1985
Quamby mudstone	Lwr Permian	Golden Valley	golden yellow	0.4	immature	Powell 1985
Quamby mudstone	Lwr Permian	Andersons Ck	fluorescence exinite	0.4	immature	Powell 1985
tasmanite oil shale	Lwr Permian	Mersey Bend	dark orange	0.8	mature	Powell 1985
Quamby mudstone	Lwr Permian	Relapse Ck	deep orange	0.8	mature	Powell 1985
Lwr freshwater sequence	Mid Permian	Golden Valley	vitrinite	0.62	mature	Powell 1985
Lwr freshwater sequence	Mid Permian	Fingal	vitrinite	0.55	immature	Powell 1985
liquid crude	Lwr Permian	Lonnavele	aromatic maturity index	0.8	mature	Whyte & Watson 1996
mudstone	Lwr Permian	Bruny Island @ 900m	vitrinite	3.57	overmature	AMDEL, G31 in Woods 1995

TABLE II

Chart showing cumulative thickness of major units in Tasmanian Basin and resultant maturity levels assuming lowest, average and greatest thicknesses. Thickness estimates from Summons (1981) and definition of oil and gas windows from Hunt (1979) and North (1985). Geothermal gradient is assumed to be 27°C per km (=15° F per 1000 feet).

	THICKNESS		
	low	average	maximum
Tertiary	10m	500m	1000m
Jurassic dolerite	250m	300m	750m
Upper Parmeener SuperGp	365m	500m	655m
Lower Parmeener SuperGp	645m	700m	981m
total thicknesses	1270m	2000m	3386m
Vitrinite R_0	0.4	0.6	1.0
	immature	mature	very mature
		(oil window)	(oil window+wet gas)

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OIL and GAS

in

TASMANIA

THE EXPLORATION PROGRAM

of

GREAT SOUTHLAND MINERALS PTY LTD

ACN 068 650 386

October 1996

CONTENTS

The Exploration Program
The Seismic Program
The Drilling Program
Estimated Expenditure
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The Exploration Licences

When the company was formed in 1995, it acquired an existing oil exploration licence and shortly after took out two further exploration licences.

The three exploration licences are EL 1/88, EL 9/95 and EL 21/95. These licences cover the area considered to have economic potential for oil and gas and cover over 70% of the accessible part of the Tasmanian Basin.

The Company's Exploration Strategy is designed to maximise the discovery of commercial hydrocarbon deposits, following on from the discovery of at least two major source rocks and of reservoir potential in at least three formations.

The major source rocks are

- the Ordovician Gordon group carbonates are in the oil window in the south and central parts of the Tasmanian Basin
- the Lower Permian Tasmanite oil shale is in the oil window across most of the Basin
- a likely minor coal-based source, based on seeps in the south of the Basin

Potential sealed reservoir rocks are also present. They are:

- the Lower Permian Liffey Group-Faulkner Group glaciofluvial-marginal glaciomarine sandstones, which are thickest in the north of the Basin
- the Lower Permian Bundella Fm glaciomarine siliciclastics, thinning north
- further potential reservoir rocks can be found in the sandstones of the Siluro-Devonian Eldon and Tiger Range Groups, and in the paleokarst, reef and dolomite sections of the older Ordovician Group

The Overall Exploration Plan is to

- *carry out* a seismic program to a total line distance of 200 km over parts of the Tasmanian Basin where the source rocks and reservoir rocks are likely to be present at depth and where they are preferably stacked
- *identify* structural traps on these 2D seismic lines and supplement them with more seismic at 90 degrees to the original lines in order to obtain 3D information on fold closures
- *assess* the extent and thickness of the source and reservoir horizons on the seismic lines and deduce migration pathways
- *drill* suitable fold and fault traps identified by the seismic lines, and in areas of geological interest at strategic points in the Tasmanian Basin.

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**COST ESTIMATE FOR LAND SEISMIC ACQUISITION
AND PROCESSING - TASMANIA BASIN**

prepared for

GREAT SOUTHLAND MINERALS PTY LTD

by

J.M. KNIGHT

May 1996

1. INTRODUCTION

Great Southland Minerals Pty Ltd commissioned this cost estimate in order to compare the cost of additional drilling with the cost of acquiring land seismic on their exploration leases in the Tasmania Basin.

The seismic lines shot by AGSO recently (1995) represent the only industry-standard surveys shot on land in Tasmania, but are considered inadequate due (at least) to inappropriate orientation and limited extent (Leaman 1996). Line 95 AGS-T4 does however demonstrate that quite reasonable reflectivity can be obtained for some surface and sub-surface conditions. This encourages the consideration of further seismic work, and it is essential at this stage of exploration, where work programmes for the exploration leases are being reviewed in order to retain the leases, to compare drilling and seismic costs.

2. PROGRAMME DEFINITION

The objectives of further seismic work at this stage are:

- to further test the seismic method
- to obtain dip-line as opposed to strike-line data
- to obtain coverage over source rocks and reservoir rocks
- to better define structural styles in the reservoir rocks
- to encourage further investment in the exploration of the Tasmania Basin

Young (1996) points out that it will be practically impossible to define potential trapping structures with only magnetics or gravity. Maynard (1996) also calls for more seismic sections across the basin to define the structural influences on the reservoir rocks. Therefore the broad aim is to cross the basin with lines which will give better definition of structural styles.

The hope is that this seismic programme will be one step closer to encouraging investment in further work to better define new drilling targets.

The lines proposed below are located after discussions with Clive Burrett, Malcolm Bendall, and Bob Richardson, as well as consideration of Leaman's (1996) comments and conclusions. It is not suggested that the line locations are set in concrete at this stage, but in terms of covering objectives, predicting field conditions, and giving a minimum number of

kilometres required, they suffice for the purposes of this cost estimate. The lines are arbitrarily numbered 97-1 to 97-9, and there is no order of priority implied.

Line 97-1: Hunterston Dome - 30 kms

Fairbridge (1949) described a feature called the Hunterston Dome which is located south-east of Waddamana, just east of the Lake Highway near Hermitage. A line across this Permian structure in a SW to NE orientation should give good coverage, and hopefully some definition of source rock reflectors. As Richardson (pers. comm) pointed out, since the actual structure appears to be well defined from field mapping, it will also provide a good test for the seismic method. To further define the structure and test for closure seismic should be shot along the Lake Highway (SSE to NNW).

Line 97-2: Ellendale to Langloh - 15 kms

This line is an attempt to obtain coverage towards the western edge of the basin, to look for expression of the Gordon Limestone at depth, and the overlying Permian. The original desire to cover even further west towards the Florentine Valley does not appear practical logistically. Another location suggested for this line between Maydena and Westerway would probably be a strike line, where dips are known to be high. There is also a major gravity high close by which could well be a large volume of dolerite which could adversely affect seismic data quality.

Line 97-3: Line T5 to Repulse - 15 kms

Objectives as for 97-2, this line is proposed to pick up the south end of Line 95 AGS-T5 and extend coverage west past Ouse towards the Repulse Dam.

Line 97-4: Tunbridge - Interlaken - 40 kms

The northern end of AGSO Line 95 AGS-T4 gave the most encouraging seismic results of any ever shot onshore Tasmania. However, it was oriented parallel to, and immediately above a major basement change, and would have been better oriented east-west (Leaman 1996). The roads between Tunbridge and Interlaken offer an ideal orientation to obtain a seismic line crossing 95 AGS-T4 in the centre of the basin.

Line 97-5 Longford - Liffey - 30 kms

A line further north in the basin is desirable in order to cover a suspected thicker sequence of the Freshwater reservoir rocks. Several locations were discussed. A line following the road from Golden Valley towards Breona would have the right location and orientation, but it is likely to be difficult to overcome crooked line problems. An alternative is to shoot west from near Longford to Liffey and perhaps beyond. This location has the advantage that the line could be tied in with the geophysical work of Direen (1995).

Line 97-6 Seven Mile Beach - 10 kms

To investigate basin depth and structure in the southern part of the basin, with an east-west line in an area where access and shot hole preparation should be relatively straight forward.

Line 97-7 Sorell Dome - 20 kms

There is a structure to the east of Seven Mile Beach which may have closure. This can be investigated by two lines at right angles, with the east-west line effectively a continuation of Line 97-6.

Line 97-8 South Arm - 10 kms

As for 97-6, another east-west line, but further south and closer to the location of the Shittim and Jericho wells. This would be roughly parallel with a marine seismic line shot by the BMR in 1988.

Line 97-9 Lonnavaile - 15 kms

To provide a section which can be tied to the well proposed for this area. The target here is the lower fresh water sequence (potential reservoir) near the south-west margin of the basin.

These nine lines total 185 kilometres. It has been assumed that all lines lie within existing, or obtainable exploration leases, and do not enter areas where seismic exploration is forbidden by other land use regulations.

Additional lines

Since additional drilling is also being carried out, it is recommended that provision is made for follow-up seismic, based on the drilling results. The cost estimate has therefore been based on a programme of a total of 200 kilometres of seismic.

3. ACQUISITION PARAMETERS AND EQUIPMENT

The most encouraging seismic shot to date onshore Tasmania is the AGSO line 95 AGS-T4. However, this was shot as part of a crustal seismic research study with a secondary objective to define the base of the Tasmania Basin. Lines were not oriented nor located as desired for a survey to define the source and reservoir reflectors and their structure, from a hydrocarbons exploration point of view. However, source and spread parameters used by AGSO can be taken as a good starting point.

Source

Vibroseis has been ruled out partly because of the cost of mobilising vibro trucks from interstate (more than one - up to 4 - trucks would have to be used together), and also because it is known that in other parts of the world where sheets of igneous rocks are present, vibroseis is not a good source due to excessive "ringing" or reverberation. (author's knowledge of seismic in the Parana Basin, Brazil, confirmed by recent conversation with Latin American geophysicists).

The preferred source is a single shot hole with a dynamite charge. AGSO used 10 kilogram charges in holes of 20 metres nominal depth. The deepest target was the base of the crust, and 20 seconds of data were recorded. Great Southland's objectives are very much shallower, up to 2.5 kilometres for the base of the basin, and target horizons considerably shallower. Although subject to field testing, it may be possible to standardise on about 2 kilograms per hole, while retaining at least 10 metres for shot hole depth. In the Cooper basin, charge sizes of 450 grams are adequate, although targets tend to be considerably shallower. The same masking problem occurs there as well.

Shot Hole Preparation

The AGSO shot holes were prepared with a combination of a Mayhew 1000 drilling rig, mounted on a 6X6 truck, and Airtrack drilling rigs which are considerably smaller. The Airtrack rigs are considered adequate for the type of drilling to be encountered. A number of rigs (up to 6) will be required to keep up with a recording rate of 60 shots per day. An additional constraint is that charges cannot be left in holes over-night, so a wash-out crew (2 men, a pump, and a tank of water) may be required with the preloaders.

Recording Parameters

AGSO used a spread with 120 groups at 40 metres spacing and shots every 200 metres. This gave an average fold of 10, with good resolution on the northern end of Line 95 AGS-T4. After discussion with AGSO and the seismic contractor selected to assist in this cost estimate, it was decided to use a modestly tighter spread for this work of again 120 groups, but 30 metres apart, and a 120 metre shot point interval. This gives a nominal fold of 15, and a CDP spacing of 15 metres.

Some consideration was given to the question of 2D or 3D. Worldwide, 3D seismic is being used earlier than ever before in the exploration process. It is no longer just a reservoir definition tool. However it is expensive (more cables, geophones, recording equipment), and its geographical extent is normally limited to a much more prospective zone within an exploration lease, than has yet to be defined within the Tasmania Basin. It is also customary to interpret 3D using a seismic interpretation work station (more money), whereas 2D can be interpreted in the time-honoured, backside-in-air, coloured-pencil-in-hand method. Therefore the current estimate is based on a set of 2D lines.

Cables and Geophones

"State of the art" geophones are recommended, and are the "ears" of the total seismic system. If your ears aren't working well you are not going to catch everything that is going on, even though your brain may be in perfect working order. By sticking to roads and tracks, there will be no logistical advantage to employ a telemetry system, and cables will be adequate.

Recording System

Cost savings can arise by choosing a system which is readily available, rather than the latest "state of the art" system which may contain "bells and whistles" not required to meet objectives. The end of the "DFS" range of equipment developed by GSI (Texas Instruments), DFS-V, DFS-VII (current technology) are still used widely, all over the world, as are some of the similarly aged SERCEL systems.

4. PROCESSING PARAMETERS

The same contractor has provided costs for acquisition and processing. Wherever possible it is recommended that the same contractor is used for acquisition and processing. There is a vested interest in producing the best possible results from data which you were responsible for collecting. Otherwise there can be doubts and discussion about whether the acquisition or the processing contractor is to blame where results do not meet expectations, or when there are unreasonable delays in getting back processed sections. The processing parameters can often largely be left up to the contractor, subject to agreement with the client. In this case the contractor supplying the cost estimate was advised that tight control of statics, velocity and deconvolution will be expected. Close communication during processing is essential.

5. INTERPRETATION

Often forgotten in such an estimate is the cost of turning the results into something initially useful. I estimate that basic interpretation of the seismic sections should take up to 10 days, including provision of a report. At \$750 per day, this equates to \$7500.

6. COST ESTIMATION

Based on 200 kilometres of seismic according to the parameters outlined above, the cost breakdown is as follows.

	\$
Permitting, line surveying, clearing	28,000
Drilling of shot holes (1,666 holes at 10 metres)	158,270
Pre-loading	10,000
Explosives and detonators (at 2 kg per hole)	23,366
Recording Crew Mob/Demob	23,000
1 day field trials/charge size tests etc	2,900
28 days recording	82,000
Recording crew field labour 8 men x 28 days	24,000
Meals and accommodation for field labour (share)	12,000
Vehicle hire - 1 LWB Landcruiser for Recording	2,640
- 4 Flat tray utilities for cables and geophones	4,800
- Car (eg: Holden Commodore) for key people	1,800
Meals and accommodation for contractor key people (single)	6,750
Consultant "Bird Dog" (28 days)	16,800
Recording crew Standby contingency (4 days at \$2100)	8,400
Processing	43,000
Interpretation	7,500
Total cost estimate	\$432,226

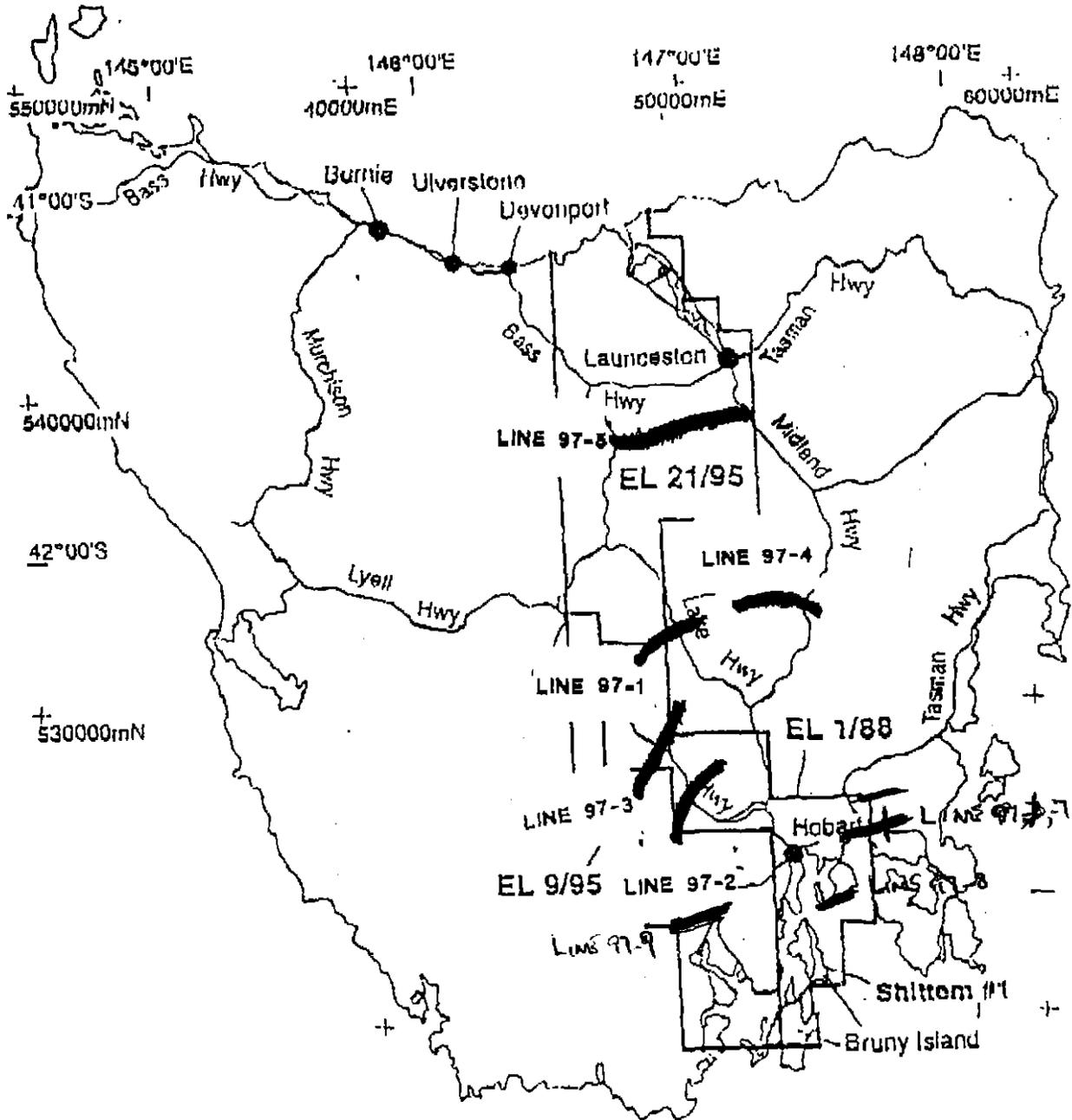
Notes:

- Seismic acquisition and processing costs based on quotation from Velseis (Brisbane)
- Drilling costs based on quotation received from Tasmanian contractor for \$9.50/metre.
- Labour based on \$ 100 per day
- Accommodation and meals based on Hamilton Hotel rates for (eg:Hydro) field staff.
- Vehicle costs from Budget Rentals, with 20% discount on Landcruiser, and 10% on others
- Explosives based on ICI quote, to Bridgewater Boral depot

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GREAT SOUTHLAND MINERALS PTY LTD PROPOSED SEISMIC LINE LOCATION



The Drilling Program

Following on from the successful shows from the Bruny Island drilling and the recently discovered oil seep at Lonnavele, the company plans to fully investigate the hydrocarbon potential of the Tasmanian Basin.

Recent research, sponsored by the company, on the sandstones of the "*lower freshwater sequence*" has shown their reservoir potential and the recent seismic work by AGSO has proven this technique in Tasmanian conditions.

Domal structures in the central and south-east part sections of the Basin will be evaluated seismically and then drilled. These and other drill-sites have been chosen because of their position in the Basin and their expected source and reservoir potential. The following drill-sites conform to this approach

Lonnavele	Close to an oil seep with a <i>tos</i> signature Above another source rock, <i>G1</i> , as predicted on geophysics. Close to a major lineament. In the south-west part of the Basin
Hunterston	Domal structure Above potential reservoir <i>lfs</i> and source rocks <i>tos</i> , <i>G1</i> In the north - central part of the Basin
Ellendale	Above a thick Permian sequence, probably over <i>G1</i> and <i>tos</i> sources Close to potential user In the central part of the Basin
Sorell	Domal structure Maybe close to or on postulated Permian deltaic sequence at margin of the Basin In the south-east part of the Basin
Clifton	Seismic shows a folded <i>G1</i> source/reservoir or Eldon Group sandstones (reservoir) Above a thin Permian sequence Maybe close to or on postulated Permian deltaic sequence In south-east margin of the Basin
Bruny (Jericho)	Already pre-collared May not have the dolerite cap A follow-up to the deep hole already drilled at Variety Bay, but on a separate geological block

Reservoir rocks	" <i>lower freshwater sequence</i> " Permian sandstones (<i>lfs</i>)
Source rocks	Gordon limestone Group (<i>G1</i>), Ordovician and the Permian Tasmanite oil shale (<i>tos</i>)

GREAT SOUTHLAND MINERALS P/L

EXPLORATION PROGRAM 1996 - 97

ESTIMATED EXPENDITURE

Seismic 200 k		
include shooting, processing, interpretation		\$433,000
Drilling		
6 holes x 1600m @ \$130/metre		\$1,248,000
Mudlogging		
150 days @ \$800/day		\$120,000
Wireline logging		
6 holes @ \$20,000		\$120,000
DST		
equipment and tests		\$100,000
Analytical testing		
geochemistry, TOC, vitrinite reflectance (AMDEL)		\$18,000
porosity and permeability (ACS Labs, Brisbane)		\$12,000
Project Personnel		
Chief Geologist		
\$4,000 per month x 7 months		\$28,000
External consultants		
eg Mulready, Carne, Young		\$20,000
Interpretation of data		
drafting (Harding P/L)		\$7,000
Support of Postgraduate students		\$9,000
Relevant documentation costs		
include maps, diagrams		\$4,000
include photocopying and printing		\$6,000
Administration of the program (TMS)		\$375,000
inc all office accommodation and costs, field staff,		
wages, secretarial support, travel and communications		
TOTAL		\$2,500,000

GERALD E. CARNE & ASSOCIATES
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Telephone and Fax (08) 332 7730

28 September 1996

Dr Julian Amos
Managing Director
Great Southland Minerals P/L
24 Jackson Street
GLENORCHY TAS 7010

Dear Dr Amos

Re: Great Southland Minerals Pty Ltd Exploration Strategy

As requested, I hereby provide you with my personal impressions and considerations regarding your exploration strategy and proposed exploration program, in Tasmania. I believe that it is important that I also make comment on the level of technical expertise that is guiding you in your exploration planning and in the subsequent execution of these plans.

Drilling funds are currently being sought to carry Great Southland through its proposed 1996-1997 exploration program. It is my understanding that one of the primary objectives of the 1996-1997 exploration program is to establish a level of subsurface information that will attract an active, medium sized petroleum exploration company that will be willing to provide both the expertise and funding required to further advance petroleum exploration in Tasmania, while maintaining Great Southland's profile in the Tasmanian Basin at an acceptable level.

In order to attract genuine interest in the Tasmania Basin, Great Southland must first clearly demonstrate that there are prospective strata in the central portions of mainland Tasmania, and that there are structures of sufficient magnitude to be capable of hosting commercial volumes of oil and/or gas. Of paramount importance, Great Southland must clearly demonstrate that modern seismic methods will be able to resolve structural expression in the subsurface of the Tasmanian Basin, beneath the ubiquitous dolerite sills. Further, Great Southland must be able to satisfy interested parties that their existing Petroleum Exploration Licences are in good standing with the State Government, and that they will be retained by the current interest holders for a period of time sufficient to adequately evaluate the hydrocarbon potential of the Basin.

Exploration Program October 1996 - April 1997

The proposed drilling of six wells and the acquisition of 175 km of reflection seismic data highlight Great Southland's 1996-1997 exploration program. Already a well is currently being drilled on Bruny Island. The recording of methane in the Tillite sequence is considered significant and important and has added value to the Great Southland acreage holdings. The other six wells are to be located on the main Island of Tasmania. Together, the seven wells should provide excellent stratigraphic (source rock, reservoir, seal) control over the southern part of the area now held by Great Southland, and should also provide subsurface velocity information that is essential to the acquisition of good quality seismic data.

One might argue that fewer than six bore holes would provide sufficient subsurface information to attract outside exploration interest, if the central parts of the Tasmanian Basin are indeed prospective. The proposed drilling locations, however, appear to be carefully and well positioned and no doubt will provide a much improved understanding of the hydrocarbon potential of the Basin as a whole. The more control there is, the easier it is for an exploration company to make the decision to commit itself to a new basin.

One might also argue that the acquisition and processing of seismic data should be completed prior to selecting well locations. The primary purpose of drilling the wells, however, is to acquire subsurface stratigraphic knowledge and not, necessarily, to find hydrocarbon accumulations; - the structural positions of the wells are therefore not of utmost importance.

At least two of the forthcoming wells are to be located on surface defined domes. It may be advantageous to acquire seismic across the domes prior to locating the respective wells. The structural axis of potential reservoir intervals in the subsurface may not coincide with surface defined axis, and wells located on the basis of surface features alone will not necessarily intersect potential reservoirs in optimum structural positions. Seismic should assist considerably in identifying the optimum structural position of strata at reservoir level. On the other hand, and as indicated above, information gained from the drilling of the wells in advance of seismic, will assist in selecting optimal parameters for subsequent seismic acquisition.

I understand that Great Southland intend to shoot two normally intersecting seismic lines through each of their six well locations. This is a valid exploration strategy, but I am not certain that all of the 175 km will be required to traverse the six drill sites. Hopefully, the seismic will demonstrate that large, closed structures are present in the Tasmanian Basin.

The proposal submitted by the seismic company quoting \$408,000 for acquisition, has been reviewed by Great Southland's Geophysicist, Dr. David Leaman and should therefore be technically sound. Again, the main purpose of the seismic expenditure is to demonstrate that good quality subsurface data is obtainable.

The budget presented to me suggests that the wells will be adequately tested, logged, and otherwise evaluated.

I understand that the rig that is being used to drill the six stratigraphic/exploration wells is now capable of reaching drill depths of up to nearly 2000 metres.

Technical Expertise Available

Dr Clive Burrett is Chief Geologist for Great Southland. Dr Burrett's background is largely that of an educator. He has been teaching soft rock geology for more than 26 years and therefore must be

considered an expert in the rocks that host oil and gas accumulations. I do not know what practical experience Dr Burrett has. Considerable research regarding the petroleum potential of the Tasmanian Basin is being undertaken by Dr Burrett and some of his honour's students.

Dr David Leaman, a geophysicist with the University of Tasmania, has since the late 1980s, been regularly commissioned by Condor/Great Southland to advise on geophysical matters, and to interpret gravity, magnetic and seismic data. Dr Leaman is an expert geophysicist and would have to be considered the person most knowledgeable about the subsurface structure of the Tasmanian Basin.

Jonathan Knight, a geophysicist with some 20 years of petroleum and mining experience in Indonesia, Australia and Saudi Arabia, has recently been commissioned by Great Southland to organise the seismic acquisition/processing program mentioned above. Prior to becoming a consultant in 1995, Mr Knight was employed by Schlumberger to obtain borehole seismic data.

Jack Mulready, a very experienced independent consultant currently engaged by Melbourne based Lakes Petroleum (Otway Basin), has prepared reports for Condor/Great Southland on an irregular basis. It does not appear, however, that he has to date been significantly involved in either strategic planning or operational aspects of Great Southland's exploration program. Dr David Gravestock (an exceptionally knowledgeable geologist with Mines and Energy South Australia) has provided information and advice to Great Southland on a long term, but intermittent basis.

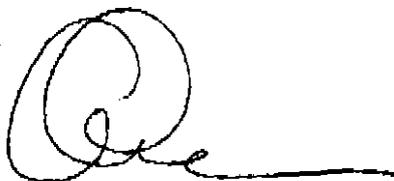
Mr Robert Young, a former Chief geologist for Getty Oil and therefore a person of considerable experience, was commissioned by Great Southland earlier this year to provide his opinion about the hydrocarbon potential of the Tasmanian Basin, and to offer advice on the exploration strategy that should be taken to efficiently explore the basin. Mr Young seems very positive in his comments.

Opinion

It is my opinion that the exploration strategy being undertaken by Great Southland is sound. Seismic is to be acquired prior to drilling wells on the surface defined domal features. Argument can be made, however, that there are advantages in drilling all of the wells prior to acquiring seismic over them. One of their primary objectives should be to demonstrate that good subsurface structural expression can be obtained in the Tasmanian Basin using modern seismic techniques. It is also important that stratigraphic control be gained in the central parts of the Tasmanian Basin through the drilling of low cost, small diameter wells. The identification of seismically defined leads and prospects would also significantly assist in attracting a farm-in partner.

It appears that Great Southland's proposed 1996-1997 work program can be fully executed if their drilling fund initiative is successful and \$2.5 million raised.

Yours sincerely



G. E. Carne

NB. The seismic program has been expanded to 200 km.

