HYDROCARBON POTENTIAL OF THE MURCHISON BASIN: A NEW WORKING MODEL

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The presence of numerous oil and gas seeps and reservoir quality sandstones in the Murchison Basin have long attracted attention. Early work was restricted to extrapolation of structure mapped at surface and resulted in three wells being drilled. Shows of oil and gas were reported from all three wells but these were not associated with beds of reservoir quality. Initial seismic of a reconnaissance nature provided little new structual information.

Recent seismic work by Striker Petroleum Ltd has resulted in a new structural interpretation of the basin. Large scale decollements have been identified along the basin margins where igneous rocks and steeply dipping, often intensely deformed sedimentary beds, overlie gently folded Tertiary strata. At least one exploration target, the Nuggety Creek Anticline, has been identified within the underlying sequence associated with the eastern margin of the basin.

Surface detail of the Nuggety Creek Anticline is obscured by a shallow, relatively flatlying overthrust sequence of granite and Late Eocene to Oligocene sediments. Gravity data and the latest seismic shows the presence of sedimentary strata beneath what was considered to be granitic basement. This sedimentary section includes a thick sequence of potential reservoir beds, overlying autochthonous basement. An interstitial soil gas survey over the structure delineates ring shaped geochemical anomalies coinciding with the seismic axis of the anticline. The position of the anomalies supports the presence of hydrocarbons in the structure.

INTRODUCTION

The Murchison Basin is located in the north western part of the South Island of New Zealand (Fig. 1), between the South Taranaki Graben and Westland Basin, which form southern onshore extensions of the productive Taranaki Basin. The basin covers an area of approximately 1300 km² and includes a late Eocene to middle Miocene succession up to eight kilometres thick. The presence of oil and gas seeps, mature source rocks and reservoir quality sandstones make the basin attractive for oil exploration.

In its present regional tectonic setting the Murchison Basin lies adjacent to the major bends in the Alpine Fault described by Suggate (1979). The area represents a transitional regime between the dextral transcurrent Alpine Fault domain of the more southerly South Island, and oblique shear and compression of the northern South Island and eastern North Island relating to the active Hikurangi Trough (Fig. 1). In this situation, changes in relative motion between the Indian and Pacific Plates have had a marked influence on the structural development of the basin. Three tectonic phases comprising rapid late Eocene and Oligocene subsidence, slow Miocene subsidence and basin infilling, and intense post-Miocene deformation associated with compression perpendicular to the regions's north-northeast structural grain, characterise the basin.

The major stratigraphic work on the basin was done by Suggate (1984). This was further developed in the course of this study, and is shown in Fig. 2.

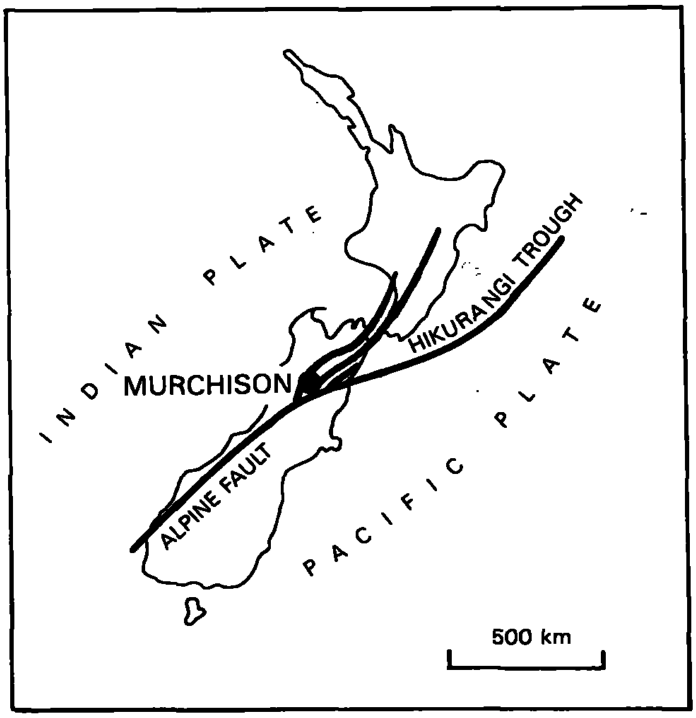

Fig. 1: Location map.

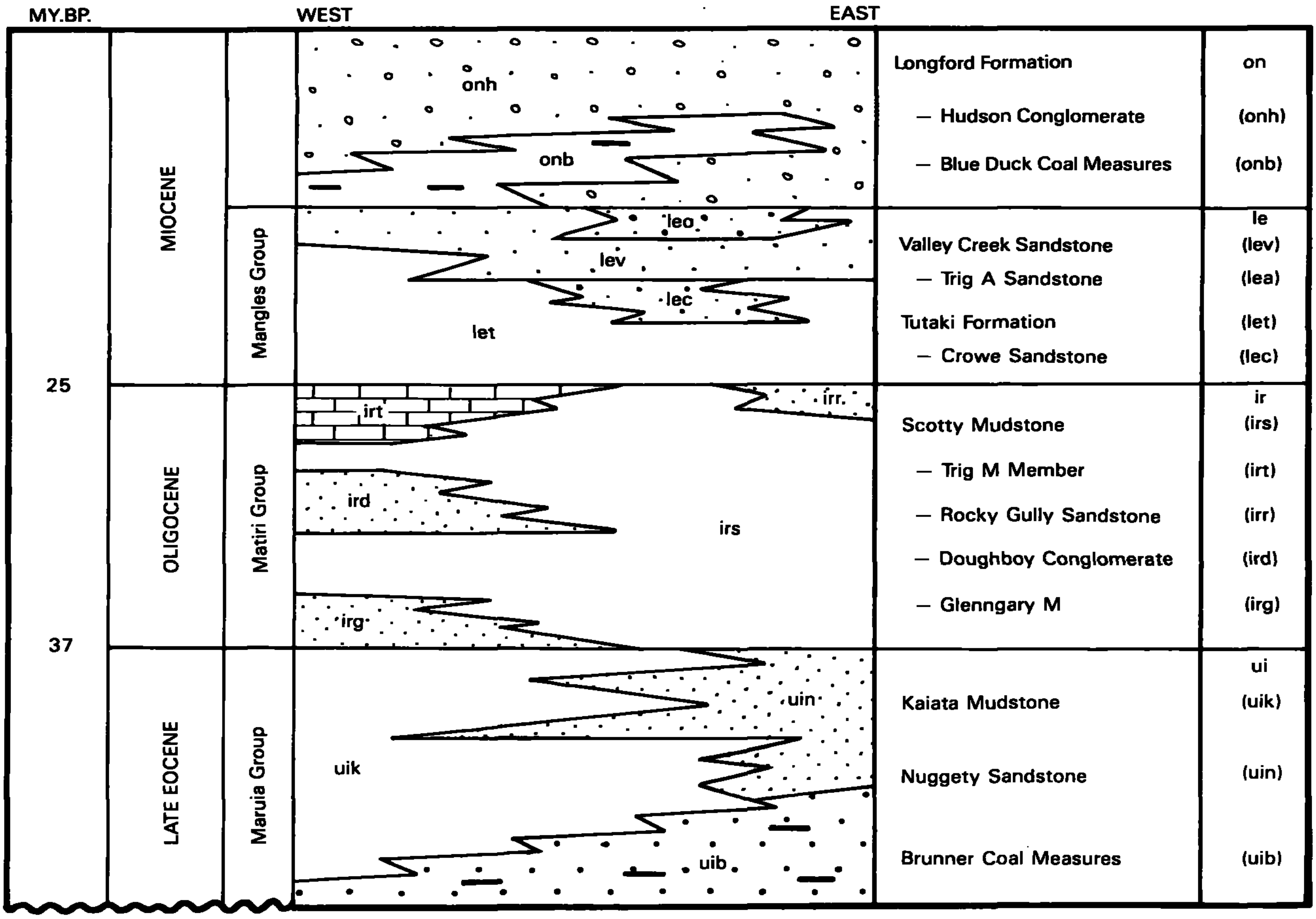

Fig. 2: Lithostratigraphy of the Murchison Basin.

EXPLORATION HISTORY

Four exploration wells have been drilled in the Murchison Basin, of which three are on the faulted Blackwater Anticline. The first well, Murchison-1, drilled in 1925-27 by the Murchison Oil Company, was located alongside a small oil seep near the junction of the Mangles and Blackwater Valleys (Fig. 3). The well penetrated early Miocene Tutaki Formation to a total depth of 1245 m, and had shows of gas and oil.

Superior Oil Company mapped the Blackwater area in 1941, and concluded that the Blackwater Anticline was a tight south plunging fold lacking closure on key sandstone horizons (Nichols, 1941). In 1968 the International Energy Company drilled Blackwater-1 on the crest of the Blackwater Anticline, about two kilometres above the junction of the Mangles and Blackwater Rivers (Fig. 3). The well drilled early Miocene Tutaki Formation and upper Valley Creek Sandstone (Fig. 2) to a total depth of 637 m. The well had strong shows of oil and gas and was shut-in as a non-commercial producer pending stimulation. This programme did not eventuate, but small quantities of oil are still periodically bled from the well.

In 1970 Bounty Oil Limited drilled Bounty-1, two kilometres further up the Blackwater Valley. The well was designed to test the reservoir potential of the upper sands of the basin and was drilled to a total depth of 3131 m. Due to the steep dips, 50-70°, only the Tutaki and late Oligocene upper Scotty Mudstone were penetrated (Fig. 3). Hydrocarbon shows were recorded, probably from fracture of these mudstones. The well was plugged and abandoned.

The recent phase of exploration commenced in 1978 when the Petroleum Corporation of New Zealand (Exploration) Ltd (Petrocorp) acquired 24 km of Vibroseis across the central part of the basin. In 1985, Petrocorp acquired a further 17 km of dynamite seismic from the lower Matiri Valley and late in 1985 drilled Matiri-1 (Fig. 3). The well drilled Eocene Brunner Coal Measures, Nuggety Sandstone, and Kaiata Formation, before it penetrated basement at a total depth of 1467 m. Although shows were recorded and some intervals tasted, the well was plugged and abandoned due to poor reservoir characteristics in both the primary and secondary targets.

Subsequent to Matiri-1 being drilled, Striker Petroleum (then Lux Oil N.L.) operated in the basin and undertook detailed structural and stratigraphic mapping, interstitial soil gas sampling projects, the acquisition of 55 km of Vibroseis, and the reprocessing of much of the existing seismic data. The interpretation of the data acquired during this programme, and the existing geological and geophysical data is the subject of this paper.

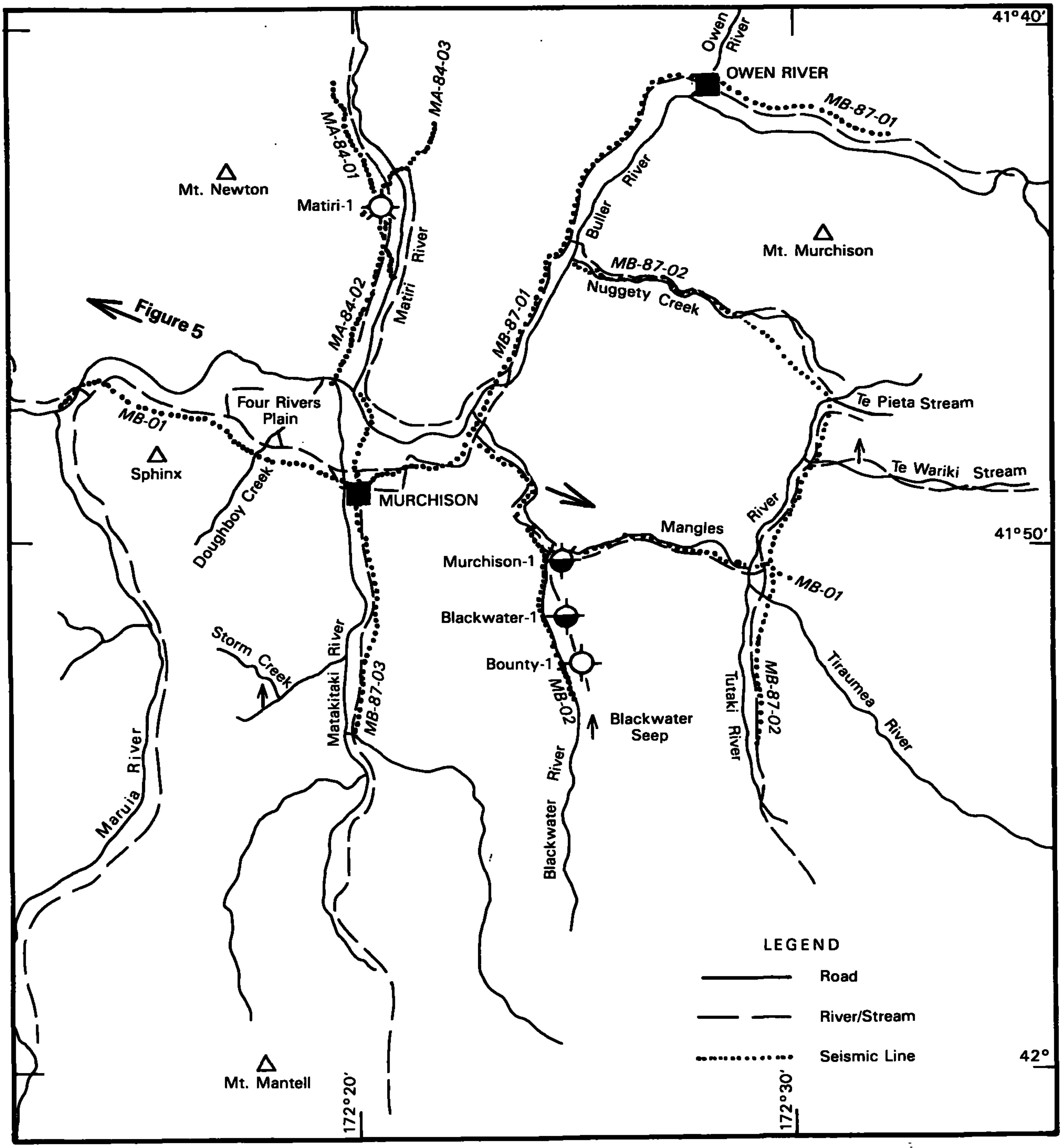

Fig. 3: Locality map.

STRATIGRAPHIC NOMENCLATURE

Reconnaissance mapping of the Murchison Subdivision by Fyfe between 1926 and 1929 (Fyfe, 1968) provided the basis for subsequent stratigraphic subdivision of the basin. Amendments by Crooks and Carter (1976) in reviewing the type sections of the Maruia and Matiri Groups, and detailed remapping of the Murchison area by Suggate (1984) resulted in revision of Fyfe's classifications and established the basin's stratigraphy and structure.

The stratigraphic nomenclature adopted in this paper follows Suggate (1984). Differences include increasing the rank of Suggate's Maruia, Matiri and Mangles Formations to group status, and raising the rank of his Brunner Coal Measures, Nuggety Sandstone, Kaiata Mudstone, Scotty Mudstone, Tutaki and Valley Creek Sandstone Members in the basin to formation status (Fig. 2). These changes emphasize the importance of the widespread stratigraphic units within the Murchison Basin and are in keeping with the stratigraphic nomenclature adopted by Nathan (1974) for the adjacent north Westland and lower Buller regions.

Name changes associated with Nuggety Sandstone and Blue Duck Coal Measures (new names) are designed to emphasize the lithologic character of economically important stratigraphic units. The Nuggety Sandstone is restricted to marine, sandstone dominated sequences within the Maruia Group, in which sandstone beds comprise at least 50% of the sequence. This agrees with the type section of the original member, but differs from Suggate's definition, which included sequences ranging from coarse granite-derived sandstones, grits and pebbly conglomerates, to mudstone-dominated sequences comprising alternating arkosic sandstone and carbonaceous mudstone, as drilled in Matiri-1. The type section remains as that defined by Suggate (1984).

MAJOR STRUCTURAL ELEMENTS OF THE MURCHISON BASIN

The Murchison Basin is subdivided on the basis of lithologic content and structure into eight major structural blocks. These are the Sphinx Trig and Mantell Blocks of the Western Platform, the Western Tectonic Zone, Longford and Tutaki Synclines, Eastern Tectonic Zone, Eastern Platform and Mt Murchison Overthrust (Fig. 4). The blocks are all fault bounded and have relative displacements ranging from a few hundred metres to tens of km. Differences in the sedimentary and tectonic history of each block are important to the hydrocarbon potential of the basin as a whole.

WESTERN PLATFORM AND WESTERN TECTONIC ZONE

The principal characteristic of the western margin of the Murchison Basin is the presence in northern and southern outcrop of granites of the Karamea Batholith. Gently folded sedimentary rocks of the Eocene Maruia Group onlap over the granites in the northeast and sedimentary sequence of the Oligocene Matiri Group onlaps over similar granites in, and to, the southwest. The two blocks which make up the Western Platform, Sphinx Trig Block in the north and Mantell Block in the south, are separated by a narrow, 2.5 to 3.5 km wide, north-northeast trending zone of complexly faulted and folded, steeply dipping Maruia, Matiri and Mangles Group rocks (Fig. 4).

This zone of relatively complex structure, the Western Tectonic Zone, runs down the Matiri Valley, across the Four Rivers Plain and along Doughboy Creek to Glengarry (Fig. 3), where it continues to the southwest as a sliver infaulted into granites of the Karamea Batholith. The juxtaposition of formations indicates substantial reverse faulting has occurred within the zone, particularly at contacts between basement and Tertiary rocks. The Petrocorp Matiri-1 well was drilled on an anticline in the Western Tectonic Zone.

Relatively flat lying seismic reflectors are present at around 1.3 seconds TWT beneath the platform (Fig. 5). These are

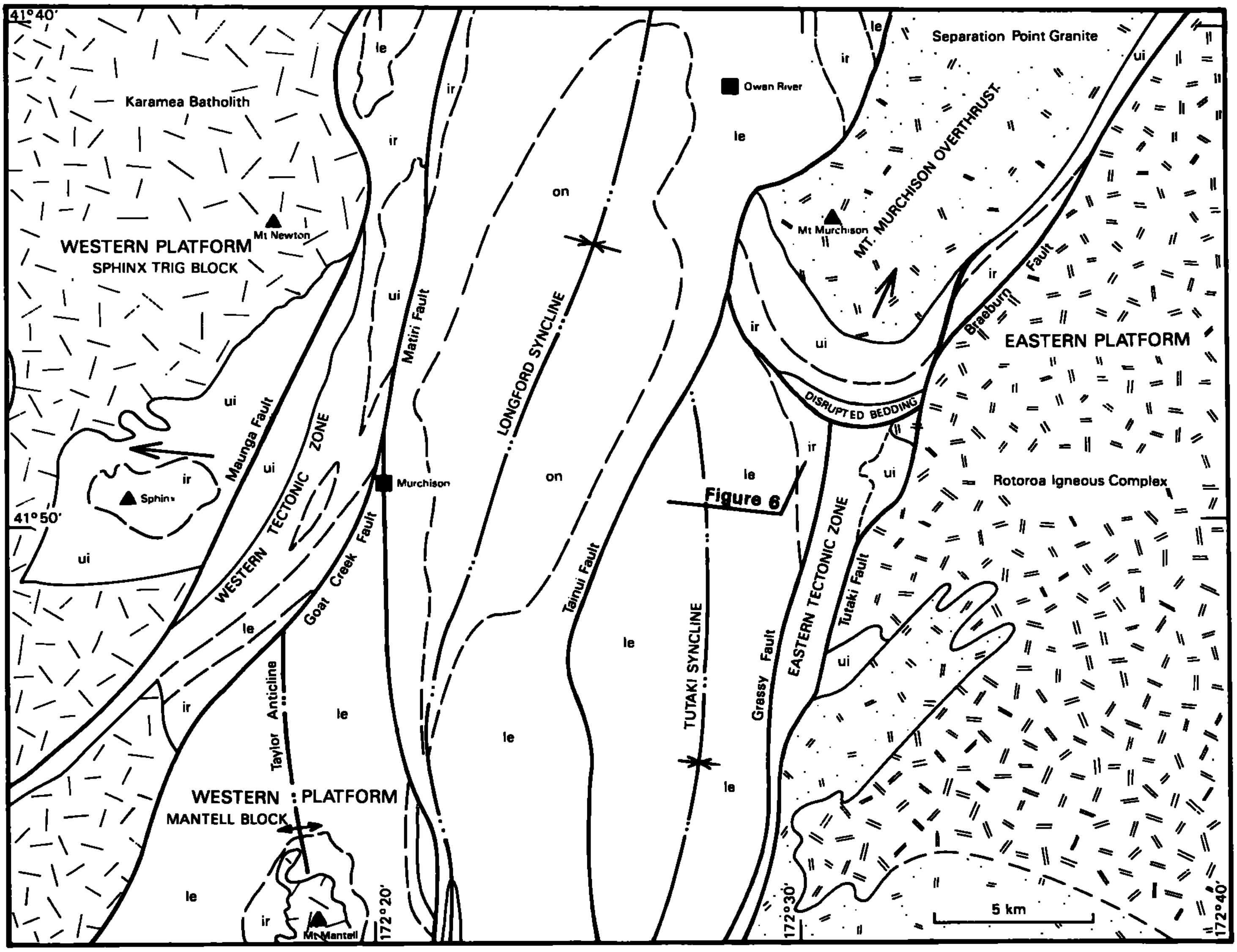

Fig. 4: Structural elements of the Murchison Basin.

associated with the sedimentary sequence on the Western side of the adjacent Longford Block and can be traced to the west, beneath granite of the Sphinx Trig Block outcrop (Figs. 5, 6). The full extent of the decollement between the granite and what is probably Matiri and/or Mangles Group is unknown. Structural relationships indicate that the decollement does not extend beyond the White Creek Fault, 16 km west of Murchison, and the Maunga Fault to the south. To the north-northeast the Western Platform sequence of the Sphinx Trig Block extends as a continuous belt for at least 50 km. The decollement may underlie the whole or any part of this sequence.

To the east, the decollement continues beneath the Western Tectonic Zone, at about 1.3 seconds TWT, to the Matiri Fault and separates steeply dipping and complexly deformed rocks from underlying relatively flat lying strata at depth (Figs. 5, 6).

LONGFORD SYNCLINE

This structural block, which takes its name from the narrow *boat-shaped* (Suggate 1984) Longford Syncline, is bounded by the Matiri Fault in the west and Tainui Fault in the east (Fig. 4). Seismic interpretation indicates the deepest part of the syncline lies about 2.5 km to the north of Longford. No basement reflector could be identified in this area although geological evidence suggests that at least eight kilometres of sedimentary rocks are present near the core of the syncline (Suggate, 1984).

Detailed mapping indicates that a high-angle fault, upthrown to the west, coincidés with the axis of the syncline. This is most evident in the lower Mangles River section where fine grained carbonaceous beds of upper Longford Formation are exposed on the eastern side of the fault and coarse fluviatile conglomerates are exposed on the western side. As fine-grained rocks comparable to the eastern sequence are not known on the western side of the fault at least 50 m of uplift and erosion must have occurred. The similar stratigraphic thickness of beds on both limbs of the syncline indicates uplift has been relatively minor.

Relatively steep dips, and continuity of sequence associated with both limbs of the syncline, indicate that the fold remained a structural entity while the basin under-went post-Miocene compression and shortening, perpendicular to its axis. Most deformation has been accommodated internally as evidenced by the intense shearing of less competent fine-grained carbonaceous beds, and by the increase in wet rock densities near the core of the syncline where the compressional forces were greatest (Suggate, 1984).

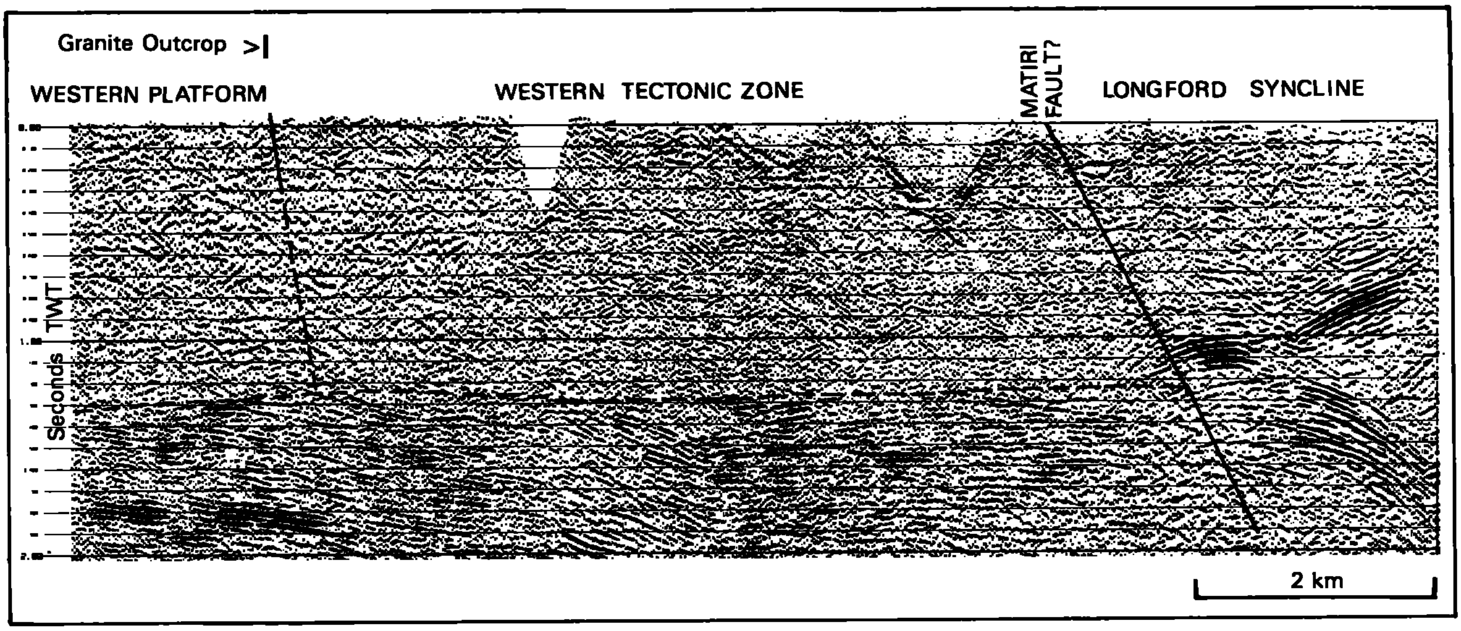

Fig. 5: Part of seismic section MB-01, central western Murchison Basin.

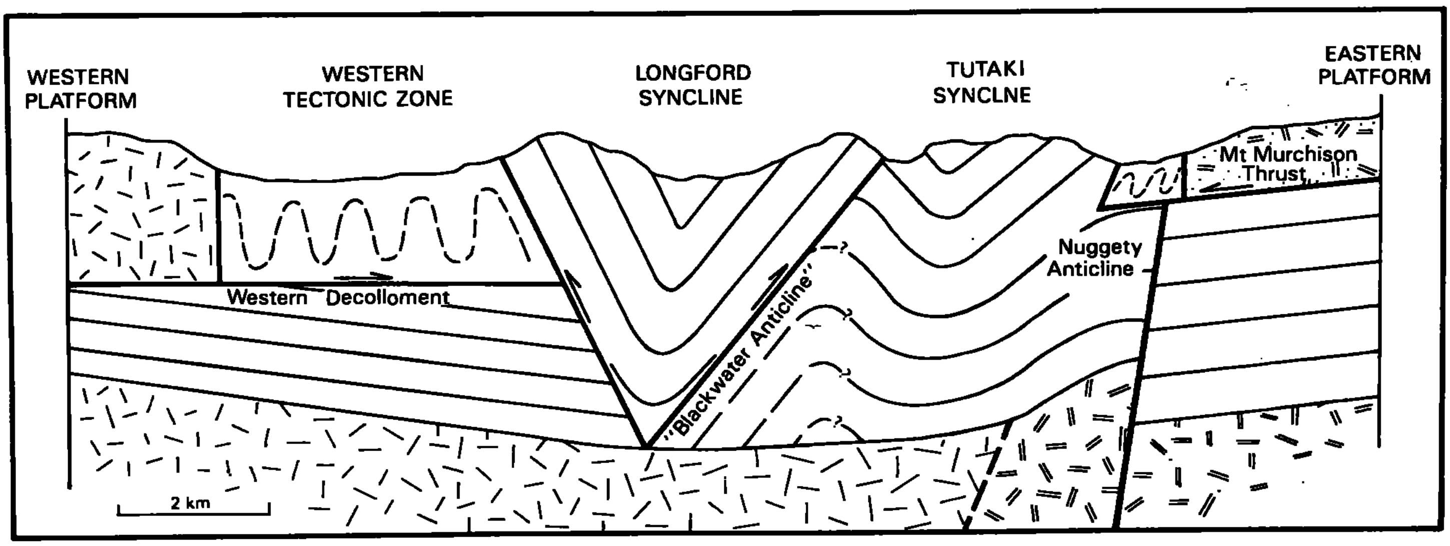

Fig. 6: Diagrammatic section of the Murchison Basin.

TUTAKI SYNCLINE

This structural block, which takes its name from the Tutaki Syncline, lies between the western Tainui Fault and the eastern Tutaki Fault. The block also includes the Nuggety Creek Anticline, a broad south plunging fold, which was first identified on seismic acquired by Striker Petroleum in 1987 (Fig. 4). The anticline strikes north to north-northeast parallel to the syncline, although the Mt Murchison Overthrust block overrides the anticline and obscures detail of its structure (Fig. 3).

EASTERN PLATFORM AND EASTERN TECTONIC ZONE

The eastern margin of the Murchison Basin overlies a batholithic complex of Rotoroa Complex granodiorite intruded by Separation Point Granites, referred to as the Eastern Platform. The basin margin is characterized by gently folded coarse-grained sedimentary rocks of the Maruia Group onlapping eastwards onto the basement suite. The western boundary of the Eastern Platform lies against a narrow zone of steeply dipping, complexly deformed strata, the Eastern Tectonic Zone. The northern part of this zone is overridden by the Mt Murchison Overthrust.

In the vicinity of Te Wiriki and Te Peita Streams, the Eastern Tectonic Zone includes an overturned sequence of Rotoroa Complex and Maruia Group sediments, thrust over Scotty Mudstone (Figs. 2, 5). East of the overturned sequence the high angle Braeburn Fault, with a substantial upthrow to the east, trends north to northeast across the adjacent Braeburn Range to the Gowan Valley.

Immediately northwest of the Braeburn Fault, a southwest dipping succession of the Maruia and Matiri Groups is in faulted contact with granites of the Mt Murchison Overthrust. The base of the succession is a thin mudstone-dominated Brunner Coal Measure sequence. This type of sequence is similar to the sequences in the western and northern parts of the basin and to the overturned sequence near the Braeburn Fault. These fine-grained rocks differ markedly from the thick coarse-grained Brunner Coal Measure sequences in the vicinity of Nuggety Creek and Tiraumea River, and indicate that they have been juxtaposed as a consequence of transcurrent faulting. Similar fine-grained Brunner Coal Measure sequences occur 15 km to the north, near the marble massif of Mt Owen (Kear, 1954) and indicate a possible origin for the fine-grained facies.

MT MURCHISON OVERTHRUST

The Mt Murchison Overthrust block includes granites of the Separation Point Batholith and onlapping sediments of the Maruia and Matiri Groups that are thrust over the Tutaki Block and Eastern Tectonic Zone. The toe of the overthrust is marked by a narrow arcuate zone of randomly orientated blocks of Scotty Mudstone which are up to 400 m across. The belt of disrupted blocks extends from the Nuggety Creek/Tutaki saddle to the Braeburn Fault in the east (Figs. 3, 4).

In the Nuggety Creek area, anomalous changes in the thickness of Scotty Mudstone and the considerably greater thickness of Tertiary section indicated by seismic, in contrast to thin sections shown by surface mapping, support the concept of an overthrust.

Nine kilometres further to the north, where the most northerly seismic line crosses the western boundary of the overthrust, reflectors associated with a sedimentary sequence can be traced at least two kilometres eastwards beneath granite outcrop (Fig. 5).

No seismic data is available further to the east, although the decollement may extend as far as the Braeburn Fault.

Isostatic gravity data from the Nuggety Creek area shows a negative anomaly centred on Mt Murchison (Anderson, 1979). At the time the gravity report was compiled the granites were assumed to be autochthonous basement and the anomaly was explained as incorrect terrain corrections. In view of Mt Murchison being part of an overthrust sequence the data may be used, reservedly, to support the existence of a thickening underlying sedimentary sequence. The eastern, southern and western limits of the overthrust are moderately well defined. Its northern extent is unknown but extends to the north beyond the area studied. Regional mapping shows granites of the Separation Point Batholith to extend as a north-northeast trending belt for at least 100 km.

SOURCE ROCKS AND MATURITY

Source rocks

Carbonaceous beds of the late Eocene Maruia Group and the late Miocene Longford Formation, are the most likely sources of the known hydrocarbons generated in the Murchison Basin.

Brunner Coal Measures

Within the Murchison Basin the late Eocene Brunner Coal Measures, which are equivalent to the upper Kapuni Group coal measures of the Taranaki basin, have been targeted as the primary source hydrocarbons. Although the formation is present over a large part of the basin, its thickness and lithology vary considerably.

In the western and northern parts of the basin, Brunner Coal Measures are up to 15 m thick and comprise poorly sorted and often muddy, carbonaceous conglomerates, grits, sandstones and with coal seams up to two metres thick. The limited thickness and volume of the coal measures in these areas indicates that there is insufficient volume of rock associated with the formation to generate sufficiently large quantities of oil and gas. Towards the east the source rock potential of the formation increases as the coal measures thicken to at least 400 m in the vicinity of Mt Murchison and the Tiraumea River.

As noted above, late Eocene Brunner Coal Measures are absent from the southwestern Mantell Block, and Oligocene rocks of the Matiri Group onlap over basement (Fig. 2).

Nuggety Sandstone

Nuggety Sandstone is similar in its distribution and development to the thick, coarse-grained parts of the Brunner Coal Measure sequence in the vicinity of the Mt Murchison Overthrust. The formation is up to 700 m thick here and comprises coarse granite-derived conglomerates, grits and sandstones with disseminated carbonaceous material throughout. The formation has developed in the western part of the basin as a localized channel fill deposit, with disseminated carbonaceous material and coal fragments up to 300 mm.

Kaiata Mudstone

The Kaiata Mudstone is widespread in the basin, and is between 500 m and 1000 m thick. The formation comprises massive dark grey to dark brown carbonaceous mudstone with minor thin interbeds of arkosic sandstone. No geochemical study of Kaiata Mudstone in the Murchison Basin has been made to determine its potential as a source rock, although average TOC values of 0.85%, and SOM values ranging from 162-476 ppm, are given for the formation in the West Coast region (Cook and Nathan, 1986). These values are based on only a few analyses and are not a reliable indication of what may be present in the Murchison area. Field data suggests that significantly higher TOC and SOM values may occur at least locally, and that the formation can not be discounted as a potential source of hydrocarbons.

Longford Formation

Vitrinite reflectance, surface geochemical data and oil seeps indicate that parts of the Longford Formation are mature for hydrocarbon generation and expulsion, although the stratigraphic position of the formation and its restricted distribution, mainly to the core of the Longford Syncline, downgrade it as a source of hydrocarbons.

MATURITY

Numerous oil and gas seeps, and hydrocarbon shows in wells, are evidence that mature source rocks occur over a large part of the Murchison Basin. As Matiri-1 has been the only well drilled in the basin to penetrate a mature source rock sequence, no direct tie between formation and source has been established.

Analyses of light hydrocarbon gases from three of the main gas seeps show an increase in heavier elements towards the eastern part of the basin (Fig. 7). Analyses of the Storm Creek gas seep from the Mantell Block, where Oligocene beds onlap over basement, show methane to predominate. This indicates that the sedimentary rocks in the area are submature. Analyses from the strong Blackwater seep, near the centre of the basin, show a bias towards methane, although a well developed tail including ethane, propane, butane and pentane, indicates that the area is sourcing gas and condensate (Fig. 7).

The Te Wiriki data, from the Eastern Tectonic Zone, plots as a much flatter curve with a well developed butane peak (Fig. 7). The bias towards the heavier end of the light hydrocarbon spectrum indicates that the area is sourcing natural gas, condensate and oil.

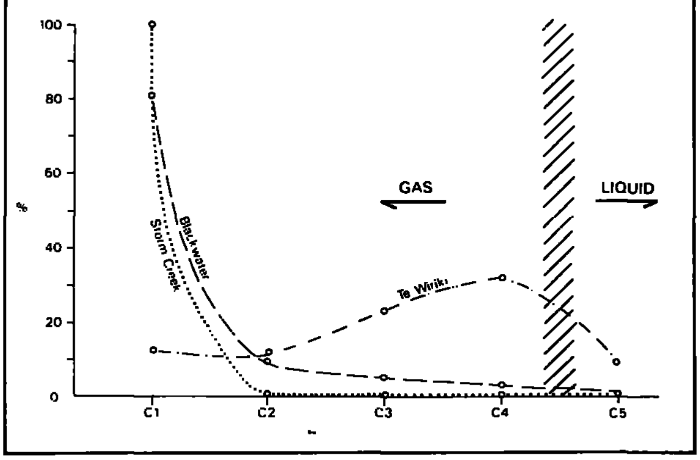

Fig. 7: Hydrocarbon Components of Storm Creek, Blackwater *Anticline*, and Te Wiriki Anticline Seeps.

RESERVOIR SEQUENCES

Potential reservoir rocks are present in each of the four main stratigraphic units, however the thickest and most consistently developed reservoir quality sandstone sequences are in the late Eocene Maruia Group. These and source rocks occur together in the eastern and western parts of the basin.

BRUNNER COAL MEASURES/NUGGETY SANDSTONE

Reservoir quality sandstones in the Brunner Coal Measures and NuggetySandstone are best developed in the vicinity of the Mt Murchison Overthrust. In this area the combined sequence is up to 1000 m thick and granite derived quartzofeldspathic sandstones, grits and conglomerates, similar to the Brunner Coal Measure/Island Sandstone sequences of the Westland Basin. The monogenetic provenance of sediments, the high proportion of feldspar, the angular shape of most sand grains and the general absence of a muddy matrix, indicates that the sequence was deposited very near source, probably as a submarine fan complex.

In outcrop, sorting within the sandstone sequences varies from poor to good, although this is expected to improve towards the more distal parts of the submarine fan complex in the west. Mechanical compaction and diagenetic effects such as kaolin replacement of feldspar and quartz overgrowths are expected to reduce porosity and permeability within the sandstones as the depth of burial increases. However, secondary porosity is expected to have developed in the more deeply buried parts of the sequence, through calcite replacing quartz.

In the western part of the basin, Nuggety Creek Sandstone is developed as a moderately well sorted channel-fill deposit associated with a submarine fan complex. No paleocurrent or detailed provenance data has been compiled for the formation, although an eastern granitic source has been postulated by Suggate (1984).

PROSPECTS

The recent work by Striker Petroleum has resulted in the identification of at least one new prospect, the Nuggety Creek Anticline, and the evaluation of three further prospects; the Blackwater Anticline, Taylor Anticline and Te Wiriki Anticline. Additional information concerning the prospectivity of the eight main structural blocks in the area has also been compiled.

WESTERN PLATFORM

The Taylor Anticline is the only major structural lead identified in the vicinity of the Western Platform. The anticline is a broad north-northwest trending symmetrical structure on the Mantell Block. The axis of the anticline rises both to the north and to the south from near Storm Creek. This precludes structural closure in the south where Oligocene beds of the Matiri Group onlap over granites of Mt Mantell (Fig. 4). In the north, closure may be provided by the northeast trending Goat Creek Fault. It may be possible to map stratigraphic closure between the southern onlap of Matiri Group and the Goat Creek Fault.

Analyses of gas from the Storm Creek gas seep near the axis of the Taylor Anticline indicate that the rocks in the area are sub-mature (Fig. 7). This agrees with the geological evidence which shows that the rock sequence in the area is less than 1000 m thick.

The Sphinx Trig Block in the northwest includes an uplifted sequence of sediments up to 640 m thick. Although source rocks including Brunner Coal Measures, Kaiata Mudstone and Nuggety Sandstone are developed in the area, no structural trap has been identified. A facies trap may exist where the channelized Nuggety Sandstone grades laterally and vertically into Kaiata Mudstone.

WESTERN TECTONIC ZONE

The steeply dipping and often complexly deformed strata associated with the Western Tectonic Zone reduces the prospectivity of the area. Although Matiri-1 proved the presence of mature source rocks, and suitable structural timing within the zone, the well also highlighted the lack of suitable reservoir sequences. Both primary and secondary reservoir objectives in the well, the Brunner Coal Measures and Nuggety Formation (Suggate, 1984) displayed insufficient porosity and permeability for sustainable production. Channel fill sandstones such as Nuggety Sandstone may be present in the area and could provide a suitable reservoir objective.

LONGFORD/TUTAKI SYNCLINES

Two main prospects are associated with the Longford and Tutaki Syncline blocks, the Blackwater Anticline in the central part of the basin and Nuggety Creek Anticline in the northeast.

Blackwater Anticline

The Blackwater Anticline represents the faulted contact between the eastern limb of the Longford Syncline and western limb of the Tutaki Syncline (Figs. 4, 6). No turnover and closure can be clearly demonstrated, and any seal appears to be broken by the Tainui Fault, as evidenced by the numerous oil and gas seeps along the axis of the structure. Seismic and gravity data indicate a basement high exists to the east of the Tainui Fault although the quality of the data is insufficient to detail the structure at depth.

Analyses of gas from the strong Blackwater gas seep indicate that mature source rocks capable of producing gas and condensate are present in the area (Fig. 7).

Nuggety Creek Anticline

The Nuggety Creek Anticline to the northeast of the Tutaki Syncline, was first identified on seismic acquired by Striker Petroleum in 1987 (Fig. 6). The anticline is a broad asymmetrical, south plunging fold and is for the most part overridden by the Mt Murchison Overthrust which obscures detail of the prospect. Three-way dip closure to the east, south and west is indicated by seismic. To the north, closure is provided by the *Sealing Fault* which is inferred from gravity, aerial magnetic and geochemical data to have a west-northwest orientation and to be downthrown at least 2000 m to the north.

A well developed package of high amplitude seismic reflectors are folded with basement over the crest of the anticline between 3300 m and 3750 m. The seismic sequence partially onlaps with basement and, based on their character, are interpreted as the Brunner Coal Measures grading to Nuggety Sandstone. They are the principle source and reservoir objectives of the prospect.

Structural contours on basement indicate that source rocks reach sufficient depth along the south plunge of the Nuggety Anticline for hydrocarbon generation and expulsion somewhere beneath the Mangles River, 15 km to the south. As this kitchen area lies immediately down-dip from the structural culmination of the prospect, a natural migration pathway exists up the axis of the anticline to charge the structure with hydrocarbons.

A soil gas survey measured light (C1-C5) hydrocarbon gases over the prospect. It delineated a series of ring-shaped anomalies centred on the culmination of the anticline near the head waters of Nuggety Creek. The anomalies show a cross cutting relationship to the surface geology and appear to be related to the subsurface form of the anticline. The plot of total C2 defines two distinct anomalies over the prospect, a large anomaly in the same area of Nuggety Creek and a slightly smaller anomaly to the northwest of Mt Murchison. The physical separation of the anomalies supports the other indirect forms of evidence for the anticline being cut by the west-northwest trending sealing fault just north of Nuggety Creek.

EASTERN TECTONIC ZONE

The Te Wiriki Anticline is the only known prospect on the Eastern Tectonic Zone. Detailed mapping of the area undertaken here does not support the existence of the anticline as mapped by Burtt (1982) and Suggate (1984). The area is characterized by massive, frequently jointed, fine-grained sediments of Scotty Mudstone and where bedding can be determined, dips are almost invariably towards the south and southwest. To the north of Te Peita Stream, the complex array of 10-400 m randomly orientated blocks of Scotty Mudstone noted above mark the toe of the Mt Murchison Overthrust. Common jointing and calcite veining in the vicinity of the Te Wiriki gas seep indicates that the gas is associated with a north north east trending fault. Analyses of the gas suggest that mature source rocks generating condensate and oil exist in the area.

EASTERN PLATFORM

The Eastern Platform is characterized by gently folded late Eocene sediments of the Maruia Group which onlap over basic rocks of the Rotoroa Complex. The rocks include a Brunner Coal Measure sequence made up of conglomerate, grit, and sandstone with minor carbonaceous mudstone and stringers of coal, and massive fine grained carbonaceous beds of Kaiata Mudstone. In the lower Tiraumea Valley the coal measures are up to 500 m thick and include conglomerates with cobbles and boulders up to 420 mm in diameter. The coarse nature of these beds and the thickness of the sequence indicates that deposition was very near source, probably as a fan complex adjacent to the rapidly uplifting, faulted, western margin of the Murchison Basin.

Although source rocks may have once been buried sufficiently in the area for the generation and expulsion of hydrocarbons, post-Miocene uplift and erosion has exhumed most of the sequence and has destroyed any prospects.

MT MURCHISON OVERTHRUST

Thick source and reservoir rocks of the Maruia Group form a conspicuous part of the Mt Murchison Overthrust sequence, although the exhumation of these beds and the lack of suitable structure, precludes the likelihood of prospects being associated with the overthrust sequence. Prospects such as the Nuggety Creek Anticline lie beneath the overthrust.

CONCLUSION

Mapping and recently acquired seismic identifies large scale decollements along the margins of the Murchison Basin, where relatively flat-lying undeformed sedimentary rocks underlie granites and steeply dipping complexly deformed strata (Fig. 6). The limited seismic coverage precludes mapping the lateral extent of the decollements, although they appear to indicate several kilometres or even tens of kilometres of post-Miocene shortening in the overthrust sequence.

Post-Miocene deformation has been unevenly distributed across the basin as a consequence of the interaction between the various structural elements. The most intense deformation has occurred within the relatively shallow, Eastern and Western Tectonic Zones, where strata has been compressed between the platform sequences on the basin margin and the fault bounded synclinal sequences of the central basin. Relatively intense deformation has also occurred near the basin axis, forming the tightly folded core of the Longford Syncline. Strata associated with the lateral platform sequences and beneath the marginal decollements show relatively minor deformation.

In view of the evidence for extensive reverse faulting and decollements along the margins of the Murchison Basin, there is a need for further geophysical and geochemical exploration to delineate the subsurface structure, to evaluate the full petroleum potential of the basin.

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