THE APEA JOURNAL

PART ONE: 1969 APEA CONFERENCE

APEA

AUSTRALIAN PETROLEUM EXPLORATION ASSOCIATION LIMITED

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(1968-1969)

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APEA Councillors welcomed the Premier of South Australia, Hon. R. Steele Hall, and the Minister for National Development, Hon. D. E. Fairbairn, in the foyer of the Hotel Australia, Adelaide.

The 1969 APEA Conference

THE 1969 Conference of the Australian Petroleum Exploration Association, at the Hotel Australia, Adelaide, South Australia, from March 23-26, was by far the largest yet, if the attendance of nearly 800 at the opening session is used as the criterion.

The Conference was officially opened by the Hon. R. Steele Hall, Premier of South Australia, and the Principal Speaker, the Hon. D. E. Fairbairn, the Minister for National Development, chose the conference to make several statements of official Australian Government policy.

A number of overseas visitors attended — from Britain, the U.S.A. and Asia.

The 1969 papers included: 'A Review of the Sedimentary History of the Island of New Guinea', by J. Harrison (Continental Oil Company of Australia Ltd.); 'Geological Framework of the Continental Shelf off Northwest Australia', by R. G. Mollan, R. W. Craig, M. J. W. Lofting (Burmah Oil Company of Australia Ltd.); 'Logistics of Northwest Australia Offshore Operations', by R. Thomas (Burmah Oil Company of Australia Ltd.); 'The Use of Digital Seismic Technology in Australia', by R. M. Cone and J. Wardell (G.S.I.); 'Geophysical Investigations of Basins Marginal to the Western Great Artesian Basin', by B. E. Milton (Geological Survey of South Australia); 'Geological Framework of the Great Australian Bight', by R. Smith and P. Kamerling (Shell Development (Australia) Pty. Ltd.); 'Drilling Results from Several Southeastern Australia Offshore Areas', by J. H. Hafenbrack (Esso Standard Oil (Australia) Ltd.); 'Financing Petroleum Development in Australia', by R. G. McCrossin (Australian Resources Development Bank); 'Some Economic Aspects of the Australian Petroleum Industry', by G. R. Mountain (National Bank of Australasia Ltd.); 'The Physical Properties of Gippsland Basin Hydrocarbons', by W. J. Stewart (Hematite Petroleum Pty. Ltd.); 'The Triassic System in Western Australia', by B. E. Balme (University of Western Australia); 'Seismic Data Problems on Coastal Limestone, W.A.', by D. D. Taylor (West Australian Petroleum Pty. Ltd.); 'A New System of Tools for Better Control and Interpretation of Drill Stem Tests', by J. East (Dowell-Schlumberger); 'Glomar Challenger — A Breakthrough in Deep Water Drilling', by J.

R. Thomas—"The marine areas off the northwest coast of Australia are as remote as any oil exploration areas in the world."

J. Hafenbrack—"The decision (to commit a 24-well platform on seismic data and information from only one wildcat) —reflects the necessary reliance on and confidence in marine seismic work in order to avoid extremely expensive step out or delineation wells, and is a testimony to the effectiveness of seismic interpretation."

Professor O'Connell—". . . but all of them prompt legal difficulties within Australia which may inhibit exploration beyond the 200 metre isobath.

"Forming an Oil Exploration Company", a tableau by a group of Brisbane experts. L.-R.: Messrs. A. J. Knights (session chairman), J. M. Florence (solicitor), A. E. Ranson (stockbroker), L. W. Doggett (chartered accountant), J. N. Blackwood (vendor), I. R. Millard (chartered accountant).

P. Carroll (Global Marine Australasia Pty. Ltd.); 'Palynologic Contributions to Petroleum Exploration in the Permian Formations of the Cooper Basin, Australia', by R. J. Paten (Mines Administration Pty. Ltd.); 'Review of Geology and Case History of Petroleum Exploration in the Central Eromanga Sub-Basin', by A. C. M. Laing (Alliance Oil Management Pty. Ltd.); 'Governmental Activities in Petroleum Exploration', by J. M. Rayner (Bureau of Mineral Resources); 'Sedimentation and Petroleum Potential of the Jurassic Sequence in the Southwestern Great Artesian Basin', by O. W. Nugent (Delhi Australian Petroleum Ltd.); 'Geological Developments in the Eastern Officer Basin of South Australia', by G. Kreig (Geological Survey of South Australia); 'The Legal Aspects of Drilling in the Deep Sea', by D. P. O'Connell (University of Adelaide); 'Forming a Petroleum Exploration Company', by J. N. Blackwood (Magellan Petroleum Corporation), L. W. Doggett (Spry, Walker and Company), A. E. Ranson (Wilson and Company, Stockbrokers and Underwriters), J. M. Florence (Tully and Wilson, Solicitors), and I. R. Millard (Spry, Walker and Company).

The award winning paper was 'Geological Developments in the Eastern Office Basin of South Australia', by G. Kreig of the Geological Survey of South Australia. Mr. Kreig was presented with the APEA Plaque for 1969 by the Chairman of APEA, Mr. D. J. McGarry.

The Conference was the most heavily attended and probably the best organised of all APEA Conferences which have been held every year since 1961.

The 1970 Conference will be held in Queensland at the Chevron Paradise Hotel, Surfers Paradise, from Sunday, March 15, to Wednesday, March 18.

Main Points from the Conference Speakers:

ADDRESSES:

Mr. D. J. McGarry, the Federal Chairman of APEA, took as the theme of his address "The Problems of Progress". . . . "At the beginning the prime objective was to prove that oil and gas could be found in some quantity in Australia. This target has been attained. . . . Since the support for exploration intensified about ten years ago, most Australian companies have hoped for early production, sufficient to set up a cash flow on relatively low capital investment . . . with one notable exception this has not occurred. A few companies are about to receive their first significant income after what must be considered a relatively long barren period . . . some will be faced with an income tax situation not conducive to satisfactory return, because of the necessity in earlier years to attract investor interest through the provisions of Section 77 (A) of the Income Tax Act, which provides immediate tax concessions to the investor, but denies the company recoupability of expenditures from revenue . . . much of the

D. J. McGarry—". . . without encouragement of sufficient net cash. Australian exploration and discovery could dwindle as the known reserves are depleted."

Hon. David Fairbairn — "There are reasons why we would like to see further drilling onshore . . . it is cheaper and therefore Australian companies have more chance of undertaking this work . . . it is envisaged that the subsidy would be paid to the (foreign) company according to the proportion of the Australian equity in the (offshore) operation."

Charles T. Easley—"Of necessity, it must be established securely and firmly in the minds of companies now operating in Australia and looking for indigenous petroleum, that the price they will receive later will justify the risk."

Australian expenditure on exploration in the past has taken the form of pump priming — the pump has thereafter operated on funds attracted from overseas as well as local sources. In this sense Australians have pioneered the establishment of significant production in their own country . . . but due to the necessity to inject large sums into search and development, Australian equity has frequently been reduced to a royalty, carried interest, or a maintainable partial working interest. . . . Particularly at this time our Government should not hinder overseas funds from investment in this country, nor should we, with growing and more mature local investment, be restrained to minor interests. Government authorities, particularly those of the States, have the power through tenure control, to see that a reasonable level of all interests is maintained. . . . The problem of marketing indigenous crude changed radically when the Government decided to make an early review of the price incentive policy it introduced in September, 1965 . . . the situation was caused by the unusually rapid discovery of uncommonly large reservoirs in one basin. It is interesting to note that no further commercial crude oil discoveries have been made in Australia outside the offshore Gippsland Basin since the original crude oil discovery at Marlin in early 1966 . . . the country is forced to deal with this weighted discovery as if it were average. . . . Gippsland costs are being used as exploration and development costs for our national exploration industry. This is clearly not the case, and prices to be received for crude after September, 1970, will be insufficient to retain interest in high risk ventures . . . there is some evidence of retraction of exploration funds to other international areas, particularly at the expense of our onshore exploration.

"The Government has in fact removed the main economic incentive to search for oil in Australia . . . it is the net cash return per barrel which will decide whether worthwhile exploration will continue.

"Australian consumption of crude oil in 1971 will be around 550,000 barrels per day, and if all production were from local oilfields, one oilfield somewhat larger than the size of Barrow Island would need to be found each year, just to meet the growth rate, quite aside from replacing depleted reserves. At the present national finding cost, which, because of the relatively large reserves found at Gippsland, now approaches the gross costs of traditional oil producing and consuming countries, the replacement of produced reserves in 1971, would require the investment of over $100 million.

". . . Many oil companies will not expend the many millions of dollars required if the result is simple competition with Middle East oil. It would make better economic sense to spend such funds in the Middle East, North Africa, Indonesia or elsewhere where discovery prospects are better.

". . . APEA has recommended to the Commonwealth Government the following industry incentives: 1. Exploration subsidies; 2. A depletion allowance of 30% of gross profit after royalty; 3. Petroleum transportation allowances; 4. Extended taxation benefits.

". . . without encouragement of sufficient net cash return, Australian exploration and discovery could dwindle as the known reserves are depleted."

* * *

The Hon. R. Steele Hall, the Premier of South Australia

". . . it is a condition of the exploration for petroleum in this State, as in others, that the successful developer must pay

The opening of the Conference by the Premier of South Australia, Hon. R. Steele Hall. Seated at the table (L.-R.) are: Charles T. Easley, Vice-Chairman of APEA; Hon. D. E. Fairbairn, Minister for National Development; D. J. McGarry, Chairman of APEA; and K. M. Horler, APEA National Executive Director.

The APEA Plaque for the prizewinning paper being presented to G. Kreig by the Chairman of APEA. L.-R.: Messrs. C. T. Easley, G. Kreig, D. J. McGarry, and C. A. Martin (Chairman of the Conference Technical Papers Committee).

The Official Luncheon for the Conference. Guests included the Premier of South Australia and the Federal Ministers for Health and Navy.

to the Crown the value of 10% on his product, and we, for this reason, consider ourselves to be in the position of a partner. However on our part we are prepared to exercise our opportunity in this respect by carrying out exploration work in our own right and making results available to industry."

". . . we have, in consultation with the industry, decided to propose the establishment in Adelaide of an Institute of Mineral and Petroleum Exploration and Development. It is proposed that this Institute provide short term highly specialised courses for post-graduates of tertiary institutions and for personnel from industry to enable them to study under world-wide experts in special fields for short periods."

The Hon. D. E. Fairbairn, the Minister for National Development (precis).

". . . thirty years ago eminent geologists believed Australia could never have oil. Despite the early success at Rough Range it looked a few years later as if this prediction were true. The Government acted to encourage oil search in the late 1950s by a number of measures including oil search subsidy, tax concessions and a stepping up of the B.M.R.'s geophysical and seismic work.

"These measures had the desired effect. The position today changed drastically. Today we have: 1. Total proved and probable gas reserves estimated at 9.2 trillion cubic feet; 2. Reserves of crude oil conservatively estimated at 1,800 million barrels; 3. Areas are yet to be assessed where oil is known to exist. These included Flounder, Tuna, Snapper, Bream, and Legendre, Dampier and Mereenie.

"The Government is now studying the problems it would face if a system of pro-rationing had to be introduced.

"We have, in addition, determined that the Government regards it as open to a new producer with a small field to make a case for assistance directed to the particular circumstances of that field.

"There are reasons why we would like to see further drilling onshore. These are: 1. From the defence point of view it is less vulnerable to attack; 2. It is cheaper and therefore Australian companies have more chance of undertaking this work; and 3. The search can turn up evaporites such as sulphur, phosphate and potash.

"After lengthy consideration we have made the following decisions on the future of the oil search subsidy:

1. All wells completed before September 30, 1969, will continue to attract subsidy under the same conditions as apply today.
2. After that date the petroleum search subsidy will be extended until June, 1974, but with the following changes:
    1. One rate of subsidy known as exploration drilling will apply to both test drilling and stratigraphic drilling and will be at the rate of 30%.
    2. This will apply to all on-shore operations in Australia and Papua-New Guinea.
    3. To implement our policy of encouraging Australian equity we envisage a scheme offshore in which subsidy should be available to Australian companies operating offshore. Where the company is a foreign owned company in which there is an Australian equity it is envisaged that the subsidy would be paid to the company according to the proportion of the Australian equity in the operation.
    4. To ease the burden of repayment when a discovery is made the Government will not ask for repayment of the oil search subsidy until income from the field enables this to be repaid.

"The Government has decided to accede to the request for amalgamation (of Sections 77 (A) and 77 (AA)) and amending legislation to be introduced for this purpose will apply in respect of share capital subscriptions made after June 30, 1969. As you know, the existing concessions are due to expire on June 30, 1970. The Government has also decided that there will be no specified time limit on the period of operation of the proposed new provision."

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Mr. Charles T. Easley, Vice-Chairman of APEA

"I would like to bring special attention to the importance of the period of time between closing of this Conference and the opening of our next one in Queensland. The future of oil and gas exploration in Australia may well be at stake.

"As far as Government deliberations are concerned, we are hopeful that they will take note of certain aspects of the petroleum business in the United States and Canada . . . at the time money was available for exploration programmes, the price predicted for petroleum if production was achieved was high enough to justify the risk involved. For the most part these predicted prices are still being realised after many years.

". . . We have heard a lot lately about the fact that the price must be right for the buyer, but if the price is not right for the seller, what happens? He will be unwilling to provide the risk money necessary to locate, produce and distribute the amount of petroleum energy which the demand requires.

". . . the right price in Australia for a commodity as essential as petroleum is the price that will ensure it is always available from indigenous resources. This price must be high enough not only to cover today's operating expenses, but also to provide the vast sums necessary to encourage petroleum explorers to find, produce and transport tomorrow's requirements. Of necessity, it must be established securely and firmly in the minds of companies now operating in Australia and looking for indigenous petroleum, that the price they will receive later will justify the risk."

* * *

PAPERS:

"Continental Australia grew northward to form the island of New Guinea. Sediments of Cambrian to Cretaceous ages were deposited beyond an ever northward moving stable platform which formed part of the Australian continent. At the end of the Mesozoic the southern sediment supply ceased and from this time onward the rising land masses of New Guinea supplied the material deposited in subsequent basins. Eocene and Oligocene were times of carbonate deposition over the whole of New Guinea.

"Orogenesis at the end of the Oligocene produced land masses along the spine of the island. These contributed clastics to basins formed on either side in Lower Miocene times.

"The basin in northern New Guinea was long and relatively narrow, while that in Papua was a classical geosyncline with eugeo-synclinal and miogeosynclinal sides. Clastic sedimentation in the deep trough area of these basins was more or less continuous throughout Miocene while on the stable shelf area of west Papua and Southern West Irian carbonates were deposited. By Pliocene the Papuan geosyncline had contracted to three small basins receiving mainly continental sediments. Vigorous deposition continued in Pliocene in the North New Guinea Basin. Pleistocene times saw the basins finally filled although deposition is still active today in the Delta area of Papua."—*J. Harrison ("A Review of the Sedimentary History of the Island of New Guinea").*

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"Reconnaissance aeromagnetic and seismic surveys have provided evidence of substantial thickness of sedimentary

rocks, and revealed the presence of several major structural/depositional features. The geological significance of these features has been partly rationalised by the integration of stratigraphic and seismic data, and by interpolation of established onshore geology. Ashmore Reef No. 1 revealed a substantially complete Tertiary-Upper Cretaceous carbonate-clay sequence, a thin early Cretaceous-Late Jurassic section, containing detritus from underlying Upper Jurassic basin lavas, and part of a thick Triassic sedimentary sequence. Legendre No. 1 penetrated Tertiary, Cretaceous and Jurassic sedimentary sequences, with gross stratigraphic similarities to sequences in parts of the Carnarvon basin.

"The shelf has a block-faulted basement substructure of Pre-Cambrian rocks, related in part to the extension of major structure in Pre-Cambrian rocks of the northwest Australian mainland."—*R. G. Mollan, R. W. Craig, M. J. W. Lofting* (*"Geological Framework of the Continental Shelf off Northwest Australia"*).

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"In terms of supply ports and communication the marine areas off the northwest coast of Australia are as remote as any oil exploration areas in the world. Between Barrow Island and Darwin, a distance of some 1,000 nautical miles, only four ports capable of sustaining a marine drilling operation exist.

"In the expanse of ocean lying north of Broome and west of Darwin and extending to the coast of Indonesian Timor, only three islands lend themselves to use as helicopter stop-over points. These islands are almost in a line running due north of Broome so that westwards from Darwin no land breaks the surface of the ocean for almost 480 nautical miles, the distance to Ashmore Reef.

"The problems of transporting materials, and more particularly men, over 400 miles or more of water on a day-to-day basis are unique in the history of offshore exploration. To maintain adequate supplies of materials and provide a safety stand-by boat during drilling of Ashmore Reef No. 1, four boats were in almost continuous operation. Helicopter service for the rig required the construction of three landing pads along an island chain route.

"Because of the lack of accommodation and facilities all labour and supervision had to be based in Perth. The lack of suitable purchasing and workmanship facilities dictated the establishment of a materials and administrative section in Perth, all adding further to the lengthening of the effective line of supply and the cost of crew change and materials transportation.

"Away from the island chain still greater problem areas exist. Since the safe range of a helicopter is inversely proportional to the number of passengers carried, either means must be found to provide artificially constructed staging points to permit a high load factor or the operator must be content with increasing the number of flights for each crew change. In either case personnel transportation costs must increase. A delicate balance of cost also exists between the maintenance of high stocks of materials at a forward base, the frequency of boat runs necessary to maintain rig working stacks at a safe level, and the cost of emergency shipments."—*R. Thomas* (*"Logistics of Northwest Australia Offshore Operations"*).

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"The past few years has seen a rapid increase in the amount of digital seismic work both in the Australasian area and throughout the world.

"Two of the more recent major improvements brought about by digital processing are automated static corrections and statistical velocity measurements from normal production reflection shooting. Both of these processes are essential if the common depth point stacking techniques prevalent today are to succeed in allowing increased accuracy in the interpretation of the final seismic sections.

"Advances in computer technology in recent years add a third dimension to the seismic section-velocity. Thus the time, lateral position and velocity of every coherent event on each trace can be measured automatically on a routine basis. This leads to greatly increased accuracy in the location of geologic structures, which is still the end product of a seismic survey." —*R. M. Cone and J. Wardell* (*"The Use of Digital Seismic Technology in Australia"*).

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"Geophysical investigations by the South Australian Department of Mines since 1961 in areas marginal to the Western Great Artesian Basin and Eastern Officer Basin, bounded by 27° 30' South and 29° 30' South and 134° 00' East and 136° 00' East, have upgraded the prospects of the area.

"This work in conjunction with geological mapping and drilling by the S.A. Government and exploration companies has enabled an interpretation to be made of the extent, depth and configuration of the Arckaringa Basin, Boorthanna trough and possible sedimentary troughs extending westwards into the eastern margins of the Officer Basin.

"Estimates of the thickness of the sedimentary section are in excess of 6,000 feet in the Arckaringa basin, 75,000 feet in the Boorthanna trough and 3,000 feet in the Mount Willoughby trough. Structural turnover has been revealed by both gravity and seismic surveys in the Arckaringa basin and the Boorthanna trough and a stratigraphic hole was drilled on a seismic feature located south of the Mount Toondina piercement structure in the Arckaringa basin.

"A Devonian dolomite-anhydrite sequence was intersected in this drill hole and a seismic reflecting horizon identified with the dolomite interface mapped over much of the area. This process revealed pre-Permian structural growth and one pre-Permian structure out of a number disclosed in the basins was investigated in detail.

"The identification of the Devonian evaporite sequence and the mapping of these structures has upgraded the hydrocarbon potential of the Arckaringa basin and the Boorthanna trough." —*B. E. Milton* (*"Geophysical Investigations of Basins Marginal to the Western Great Artesian Basin"*).

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"Geophysical exploration carried out in the Great Australian Bight since 1966, combined with geological fieldwork in the adjacent land areas, has made it possible to outline the broad geological framework of the area.

" 'Basement' consists of two major units, an offshore extension of the locally metamorphic Cambrian Kanmantoo Group in the South-east and the extension of the West Australian Archean shield in the northwest. The boundary is thought to follow a trend extending westerly from the Cygnet-Snelling fault zone on Kangaroo Island.

"In two areas the basement has been downfaulted, thus creating depositional areas for thick sequences of sediments, namely the Elliston trough to the west of Eyre Peninsula and the Duntroon basin, south of Eyre Peninsula and west of Kangaroo Island.

"The geological setting of the Duntroon basin appears to be comparable with the Otway basin and a Jurassic-Cretaceous age is assumed for the folded sequence of sediments overlying the basement and underlying the Tertiary with angular unconformity. The basin was possibly partly and temporarily closed to the south and open to marine influences to the west.

"The lower part of the section in the Elliston trough which has low to medium velocity seismic character, is probably Mesozoic, as is evidenced by the upper Jurassic rocks encountered in its onshore extension. Proterozoic-Cambrian sediments may overlie the basement in the eastern part of the trough.

"Deformation of the Mesozoic is limited to the mouth of the trough where there is indication of a base of Tertiary unconformity. This trough was probably also open to marine influences to the west.

"Along the continental margin between the basins and also south of the Eucla basin a thin Mesozoic section, conformably underlying the Tertiary, is probably present, gradually thickening towards the continental slope. In the onshore area, Tertiary sedimentation started with local deposition of clastics during the Middle Eocene, which also may have been the case off the eastern part of the Eucla basin, in the Elliston trough and in the Duntroon basin. Carbonate sedimentation took place from the Upper Eocene onwards, to reach its widest extent during the Lower-Middle Miocene. A hiatus during the Oligocene may have occurred in the western part of the Bight as is the case in the Eucla basin.

"Only weak deformation of the Tertiary in the offshore area has been observed. This generally occurs over Mesozoic structures in the Duntroon basin and as draper over topographic basement highs at the mount of the Elliston trough.

"No significant hydrocarbon indications are known from the surrounding land areas, but the well-documented bitumen strandings along the coast point to offshore seepages indicating generation of hydrocarbons in the general area.

"At this stage prospects must be regarded as speculative, although a folded probable Mesozoic sequence forms an objective in the Duntroon basin while prospective Mesozoic-Tertiary section appears to be present in the Elliston trough, where structural evaluation is still at a relatively early stage." —*R. Smith and P. Kamerling ("Geological Framework of the Great Australian Bight")*.

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"Three specific prospects drilled by Esso in exploring the continental shelf of southeastern Australia are reviewed. These anomalies differ considerably in their objective horizons, anticipated trapping mechanism and in results. They represent only a small portion of the numerous structural and stratigraphic types of play present in the Otway, Bass and Gippsland offshore basins.

"The Argonaut Prospect located offshore South Australia was drilled on a seismic defined fault closure with the primary objective being sandstones within the Upper Cretaceous. The anticipated Upper Cretaceous sands were present, but no shows of oil or gas were encountered to total depth. The unique type of faulting and the large number of faults present in this area are extremely interesting from an exploration standpoint, particularly as in other areas of the world appreciable reserves have been established from similar structural provinces.

"The Bass-3 Prospect in the Bass Basin was the third dry hole drilled by Esso in this large offshore basin. The location was determined by seismic and consisted of a 22 square mile anomaly with 300 feet of closure. Adequate reservoir beds and associated cap rocks were present, seemingly suitable source rocks were available, timing of growth of the structure was early, yet only one non-commercial show of gas was encountered. This wildcat was the first to find Upper Cretaceous sediments in the Bass Basin.

"The Halibut Prospect in the Gippsland Basin is a very interesting anomaly both from a scientific and an economic point of view. Esso's decision, based on seismic data and with information from only one wildcat in committing a 24-well platform with related facilities may well be a milestone in commitments of this size. It reflects the necessary reliance on and confidence in marine seismic work in order to avoid extremely expensive stepout or delineation wells, and is a testimony to the effectiveness of good seismic interpretation. The trapping mechanism at Halibut is provided by an Oligocene channel which cuts across a southwesterly plunging nose, forming a sizeable closure on the Eocene Latrobe Valley unconformity down dip from the channel. Substantial recoverable oil reserves are estimated to be present and production from the Halibut Field will begin in 1969."—*James F. Hafenbrack ("Drilling Results from several Southeastern Australia Offshore Areas")*.

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"Rapid industrialisation and a rising standard of living have resulted in an upsurge in energy requirements. Consumption of primary energy in Australia during the post-war period has grown at a faster rate than either the United States or Western Europe, although not to the same extent as the Japanese market. Concurrently, there has been a shift away from the more traditional fuels to petroleum products, and to a lesser extent to brown coal and hydro-electric power. These developments are the result of a number of factors, both technological and economic.

"The growth of indigenous supplies of crude oil will result in marked savings of foreign exchange, both directly in the form of reduced import costs of petroleum, and indirectly in the form of reduced freight expenses. Interest shown by overseas industrialists also suggests that we might become an exporter of liquefied petroleum gas to the Japanese market. We should also bear in mind the possibility of Australia eventually becoming an exporter of crude oil, although of course such an event is contingent on many unknown factors.

"Industry itself should benefit greatly from these discoveries. New industries will be developed as these fuels with their chemical by-products become available, and the future spread of natural gas pipelines should lead to significant industrial decentralisation.

"Consumers will be provided with a relatively cheap, efficient fuel in natural gas, and expansion in the scope and size of this market is likely.

"Pricing problems may cause difficulties, while the question of distribution and control of oil and gas resources could lead to interstate friction. The need to reconcile Commonwealth and State financial differences may also arise.

"Many of these problems will no doubt be capable of solution in the longer-term. Although there may be difficulties confronting the effective utilisation of Australian oil and gas discoveries, nobody should imagine that these discoveries are not of great importance to Australian development." — *George R. Mountain ("Some Economic Aspects of the Petroleum Industry")*.

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"Since the beginning of offshore drilling in the Gippsland basin, during 1964, hydrocarbon accumulations have been encountered in nine of the ten exploration wells drilled. Commercial gas fields have been proved at Barracouta and

Marlin with estimated total recoverable reserves of 5.8 trillion cubic feet wet gas. The Halibut and Kingfish fields are estimated to contain total recoverable reserves of 1,500 million barrels of oil. Minor accumulations of oil have been encountered at Barracouta and Marlin and are currently being evaluated. Other accumulations, presently considered non-commercial, were found in the Dolphin and Perch fields. Recent discoveries in the Snapper, Tuna and Flounder fields are yet to be appraised.

"Generally, analyses of gases discovered in the Gippsland area show them to be of good quality with a methane content in the order of 80-85% and yielding 30-70 barrels of liquids per MMCF. Hydrogen sulphide of 45-55 ppm has been found in the Barracouta gas but only a trace has been reported in the Marlin gas. Commonly, the percentage of non-hydrocarbons in the gas is low in the shallower horizons but appreciable quantities exist in the accumulations encountered at depth.

"Oils are generally of low sulphur content and range in gravity from 40° A.P.I. to 64° A.P.I. Gas-oil ratios of 100-1,100 cubic feet/barrel have been measured in crudes which range from highly undersaturated to saturated. The oils are of the light variety and yield high proportions of gasoline and kerosenes and small quantities of residues. Wax contents of the crudes range from very low to 27% and pour points from 80° to 75°F."—*W. J. Stewart* (*"The Physical Properties of Gippsland Basin Hydrocarbons"*).

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"Strata of Triassic age were not certainly identified in Western Australia prior to 1954. They are now known to be extensively developed in the Bonaparte Gulf, Canning, Carnarvon and Perth basins. Except in the northern part of the Perth basin, where it transgresses on to the Lower Paleozoic and Precambrian, the Lower Triassic overlies Permian sediments disconformably or unconformably.

"The Triassic succession is essentially similar in all the sedimentary basins, apart from the extreme southern part of the Perth basin. It begins with a sequence of marine shales and sandstones which contain vertebrate and invertebrate fossils in places, and when unweathered yield rich assemblages of spores, pollen grains and especially spinose acritarchs. Ammonites of Otoceratan age occur in the northern Perth basin and palynological evidence suggests that basal Scythian strata are also represented in the Canning and probably also the Carnarvon basin. In the Onslow embayment of the Carnarvon basin marine strata of Middle and Upper Triassic age overlie the Lower Triassic. Elsewhere a regressive phase developed in the late Scythian and the younger Triassic rocks are non-marine. Continental Middle and Upper Triassic are most extensively developed in the Perth basin and a thickness of over 7,000 feet of coarse sandstones and conglomerates was drilled in Pinjarra No. 1 well without reaching the base of the unit. These are considered to represent confluent fans, adjacent to active normal fault scarps. They pass upwards with apparent transition into red beds of Lower Jurassic age. Lower Scythian continental deposits are known only from the southern part of the Perth basin where they were penetrated in a single well. They consist of sandstones and dark shales with minor coal beds.

"The Scythian Kockatea Shale is one of the main drilling objectives in the Perth basin and gas accumulations in the Dongara district are associated with the Permian-Triassic unconformity. Lithologically and palynologically, the formation notably resembles the Scythian Mianwali Formation in the Salt Range, West Pakistan, and the Lower Triassic Toad-Grayling Formation of Western Canada. The latter succession contains commercial oil accumulations."—*B. E. Balme* (*"The Triassic System in Western Australia"*).

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"The Multi-Flow Evaluator, or MFE, is a new system of tools providing an original approach to drill stem testing. It improves control during the testing operation and gives a more accurate evaluation of the fluid recovered while providing additional pressure information for reservoir analysis.

"The tools are operated entirely by up and down motion of the drill stem. This motion provides a positive means of control and offers easily observed surface indications of tool operating position. An unlimited number of shut-in and flow periods may be taken with this tool while in the hole.

"The key to the success of the MFE system of tools is the safety seal packer. Until this development, operation of the tools by up and down motion only, had proved unreliable. The success ratio of the MFE now exceeds that achieved by conventional tools.

"The equipment includes a 2,500 c.c. chamber in which a representative sample of the flowing formation fluid is trapped at the end of the last flow period and brought to the surface under pressure. The sample can be evaluated at the wellsite or transferred under pressure for laboratory analysis.

"The sampling feature of the tool allows a sample to be obtained from a reservoir which has suffered minimum influence from production. A representative sample can be obtained for laboratory or empirical analysis by employing a testing technique to minimise drawn-down flow periods."—*John East* (*"A New System for Better Control and Interpretation of Drill Stem Tests"*).

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"In 1964, a multi-university sponsored deep sea drilling proposal was initiated by "JOIDES" (Joint Oceanographic Institutions Deep Earth Survey). Participating institutions were Scripps Institution of Oceanography, Woods Hole Oceanographic Institute, Lamont Oceanographic Laboratory of Columbia University, and Miami University's Institute of Marine Science.

This programme envisioned retrieving sediment cores in 12,000 to 18,000 feet of water. Its planning led to the current Deep Sea Drilling Project which is funded by the United States National Science Foundation. Scripps Institution was designated the manager of the Project and subsequently awarded Global Marine the drilling contract of an 18-month deep ocean coring programme. The 'Glomar Challenger', one of the most efficient and sophisticated ships afloat, is the result.

"The design of the 'Glomar Challenger', with her dynamic positioning and advanced drilling systems, was not hurriedly thrown together. The entire concept had been under study for several years. When the proposal was received from Scripps, substantial prior work was available to allow the preparation of a drillship capable of achieving the aims sought in the project."—*James P. Carroll* (*" 'Glomar Challenger' — a Break Through in Deep Water Drilling"*).

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"From 1959, when Permian spores and pollen were first identified from Delhi-Santos wells in the Cooper basin, until 1967, appreciation of the palynologic succession was impeded by problems associated with the servere carbonisation of the microfossils. By 1966, sufficient data had been accumulated for the elucidation of the broad palynologic framework. The Merrimelia Formation was identified as early Permian (palynologic unit P1b of Evans), the Lower and Middle Members of the Gidgealpa Formation as Lower Permian (units P1c-P3a) and the Upper Member of the Formation as Upper Permian (units P3b-P4). Breaks in the microfloral succession were observed above the Merrimelia Formation and between

the Middle and Upper Members of the Gidgealpa Formation corresponding with observed litho-stratigraphic hiatuses.

"Well-preserved microfloras were recovered from our wells drilled in late 1967 and early 1968, and produced a dramatic advance in knowledge of the Permian bio-stratigraphy. It became possible to relate the microfloral succession to the Permian palynologic stages proposed by Evans (1967) for eastern Australia. The Merrimelia Formation was referred to stage 2, while stages 3, 4 and 5 were recognised within the Gidgealpa Formation. In addition, two units of apparently short duration were recognised in each of stages 4 and 5. A six-fold bio-stratigraphic subdivision of the whole Permian sequence was thus possible.

"This microfloral unit succession is finding wide application to problems encountered in current drilling and stratigraphic investigations. It has shown particular value when applied to those problems associated with the mid-Gidgealpa Formation disconformity, which is an important feature relative to hydrocarbon accumulation in the Gidgealpa field."—*R. J. Paten* (*"Palynologic Contributions to Petroleum Exploration in the Permian Formations of the Cooper basin, Australia"*),

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"Along the western margins of the southwestern Great Artesian basin the Jurassic sequence is an almost continuous sandstone section. In the eastern part of the same area, this sandstone sequence is broken by two shale-siltstone intervals, the Birkhead and Westbourne Formations. Towards the western margins of the basin these facies change into sandstone. The Murta Member of the Mooga Formation develops in the area north of Lake Frome through a facies change in the upper part of this formation from sandstone to siltstone and shale. It is postulated that the depositional conditions in the southwestern Great Artesian basin were dominantly fluviatile during most of the Jurassic, and that the fine grained sediments of the Birkhead and Westbourne Formations and the Murta Member of the Mooga Formation were deposited under low energy lacustrine conditions. Abundant good quality potential petroleum reservoir rock exists throughout the entire Jurassic sequence. The lack of hydrocarbon filled traps found to date and the change of the main siltstone-shale intervals into sandstone facies in the west and southwest imply that the Jurassic in the southwestern Great Artesian basin has been effectively flushed. However, the complex facies relationship to the sandstone and shale beds indicates that stratigraphically controlled traps may exist. The most prospective part of the Jurassic for commercial hydrocarbons appears to be in the lower part of the Hutton Sandstone."—*O. W. Nugent* (*"Sedimentation and Petroleum Potential of the Jurassic Sequence in the Southwestern Great Artesian basin"*).

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"The Eastern Officer basin in South Australia consists of a deep, east-west trending trough that flanks the southern margin of the Musgrave block. From its northern margin south to its axis, the basin deepens with a very steep gradient, then shallows steadily to its southern margin. Superimposed on this regional configuration are a number of anticlinal structures.

"The deepest part of the basin, indicated by geophysical exploration, occurs in the west and contains about 18,000 feet of basin fill. A Paleozoic succession overlying Proterozoic sediments with marked angular unconformity is exposed along the eastern margin of the basin. The Paleozoic succession consists of 2,000 feet of doubtful Cambrian sediments, 6,000 feet of Ordovician and Devonian sediments and an unknown thickness of a molasse-type sandstone.

"During Cambrian times, a fine greywackie facies with interbedded cherty and carbonate horizons was deposited, indicating fairly rapid burial in a shallow water environment probably restricted at times. Sedimentation continued during the following Ordovician transgression when a clean quartzose sandstone, from a more distant source was deposited in a more open environment. The sedimentary cycle concluded with the deposition of a large scale current-bedded sandstone followed by a molasse-type conglomeratic greywacke during Devonian times.

"The presence of good porosity in the Ordovician outcrops, the probability of shaly caprock in the distal areas of the basin, and the occurrence of anticlinal structures demonstrated by geophysical exploration, are encouraging features for petroleum exploration in this area."—*G. Kreig* (*"Geological Developments in the Eastern Officer basin of South Australia"*). The prize-winning Paper for 1969.

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"The Geneva Conventions, 1958, on the Law of the Sea have not operated in all respects as intended.

"In particular, the Convention on the Continental Shelf, which has not been ratified by Japan, is ambiguous respecting both the legal character of the seabed and the area over which the coastal State has sovereign rights. This area is said to be within the 200 metre isobath or further where the seabed is exploitable. But the seabed is likely to be exploitable at great depths and at great distances from the coast. Where is the cut-off point?

"This question is particularly complicated in the case of Australia because there is doubt as to the constitutional powers of Commonwealth and State to legislate extra-territorially. The Commonwealth may have power to implement a treaty, but if the Geneva Convention is interpreted so as to limit oil and mineral exploitation to the 200 metre isobath, or only marginally beyond, this power might evaporate as activity is pressed further and further beyond the 200 metre isobath. For this reason, Australia cannot be indifferent to moves now being made to establish a new legal regime of deep sea mining.

"In the United Nations it has been proposed that the seabed be internationalised for the benefit of developing countries. Others have proposed that it be the exclusive interest of countries whose flag ships actually exploit it. Yet others have proposed that the Geneva Convention be utilised to guarantee to the coastal state exploitable areas actually being exploited, but not in the case of areas merely being explored. There are variants on these suggestions, but all of them prompt legal difficulties within Australia which may inhibit exploration beyond the 200 metre isobath."—*Professor D. P. O'Connell* (*"The Legal Aspects of Drilling in the Deep Sea"*).

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SOCIAL EVENTS:

The main social events of the Conference included the Reception and Buffet Dinner, Sunday, March 23, at which the hosts were Alliance Group, Associated Group, Beach Petroleum, Continental Oil Company of Australia, Delhi Australian Petroleum, Esso Standard Oil (Australia), Exoil N.L., Hematite Petroleum, Outback Oil, Pexa Oil, Planet Oil, Santos Limited, Shell Development, Tenneco Australia and Total Exploration; the APEA Official Luncheon on March 24, the APEA Buffet and Cocktail Party on that evening, and the Conference Dinner Dance at Arkaba Hotel, on March 25, at which some hundreds of delegates and guests were present.

The Conference concluded with a cocktail party for delegates and guests on Wednesday, March 26. Hosts were Christensen Diamond Products (Australia), Geosurveys of Australia, Schlumberger Seacon Inc., Halliburton, Baroid Division National Lead Co., Davy Ashmore, Snam Progetti, Bechtel Pacific, United Geophysical, McPhar Geophysics, and Evans Deakin & Co.