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NATURAL GAS IN AUSTRALIA.

(AS AT 30 SEPTEMBER 1964.)

by

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NATURAL GAS IN AUSTRALIA

OCCURRENCE

Geographical Distribution.

The geographical distribution of known natural gas and oil accumulations in Australia is shown on the map of sedimentary basins (Fig. 1).

Natural gas was first discovered in Australia in 1900. A water well located on the outskirts of the town of Roma in the State of Queensland, struck a flow of gas at a rate of 0.446 MMcf/d (12,631m^3) at a depth of 3,683 feet, and another well drilled nearby had an initial flow of 1 MMcf/d (28,320m^3) from 3,703 feet. This gas was treated in an absorption plant, and some 30,000 imperial gallons of gasoline were extracted in the years 1928-1931.

About 30 wells were drilled in the Roma area in late 1920's and early 1930's; some of these wells had good shows of gas. After the second world war, in the 1947-1954 period, 18 wells were drilled in the area, and three of these drillstem-tested 0.55, 0.87 and 1.5 MMcf/d (15,576, 24,638 and 42,480 m^3) of gas respectively.

Another revival of exploration activity in the area coincided with the introduction of the Petroleum Search Subsidy Act near the end of 1957. To 30th September, 1964, 282 wells had been drilled in the Bowen-Surat Basin, of which Roma is a part, with the following results:

No. wells abandoned as dry or with small gas and/or oil shows	 221
No. of wells completed for oil production*	 21
No. of wells completed for gas production	 40

To the west, in the Adavale Basin, Gilmore No. 1 well drilled by Phillips Petroleum Company in September, 1964, drillstem-tested 5.37 MMcf/d (152,078 m^3) of dry gas from a Devonian sandstone at about 12,000 feet.

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* This number includes 15 oil producers of the Moonie Oilfield.

Further to the south-east, in the State of New South Wales, a show of dry gas was first recorded in a water bore drilled between 1897 and 1902, near the town of Grafton in the southern part of the Ipswich-Clarence Basin. Some of the wells drilled in the area after 1928 had significant shows of gas, the best being estimated at a maximum of 0.3 MMcf/d (0.085 m^3). No commercial significance is at present attached to these occurrences which are found in the Triassic-Jurassic sequence.

To the south-east, in the Sydney Basin, many boreholes struck shows of dry gas, the most significant being those in the Camden area near Sydney. Camden No. 7 well had the highest initial open flow of some 2.5 MMcf/d (70,800 m^3). The gas occurs in sands of Triassic age. Australian Oil & Gas Corporation has been trying to develop gas reserves in the Basin for many years, but wihtout much success.

To the south-west, in the State of Victoria, in the Gippsland Basin, the only verified occurrence of gas was in the North Seaspray No. 1 well; a small show of gas was found in a thin sandstone of poor porosity in the Lower-Cretaceous-Upper Jurassic sequence. In the Otway Basin, at least five wells had shows of gas, the best being in Port Campbell No. 1 which drillstem-tested about 4 MMcf/d (113,280m^3) of wet gas with small amount of distillate from a thin sand in the Lower Cretaceous sequence. One of the wells, Flaxman's No. 1, had wet gas shows from fracture porosity in the predominantly very fine-grained, thick sequence of Lower Cretaceous-Upper Jurassic section.

North-westward in the South Australian portion of the Great Artesian Basin, recent drilling on the large Gidgealpa structure resulted in a discovery of wet gas accumulation which may prove to be the largest found in Australia to date. Five wells have so far been drilled there, one of them (No. 1) being dry. The discovery well, Gidgealpa No. 2, found four sand reservoirs in the Permian section from which production of gas and some condensate has been obtained. In Gidgealpa No. 4, some 3,200 feet of 21° A.P.I. oil were recovered with some gas during a drillstem test of 7,081'-7,139' interval.

The seismic survey of the area has shown a closed area in Permian to be approximately 12 miles long and 3.5 miles wide with a vertical closure of about 700 feet. There are also other anticlinal structures on the Gidgealpa - Innamincka trend. (see Figures 3 and 4 supplied by Santos Limited and Delhi Australian Petroleum Ltd. respectively).

West-north-westward from Gidgealpa, another apparently large discovery of wet gas was made this year on the Mereenie structure in the central Amadeus Basin in the Northern Territory. So far, three wells have been drilled on this long and narrow anticline, which covers some 50 square miles and has 700-foot of closure, and all three produced large volumes of wet gas and some condensate on tests. There are at least two gas-bearing intervals in the Stairway Sandstone and a 300-foot gas column in the Pacoota Sandstone of Ordovician age. The Pacoota Sandstone accumulation is by far the more important of the two. (See Figure 5 supplied by Magellan Petroleum Corporation and Fig. 6 based on information supplied by Exoil (N.T.) Pty.Ltd., the operator.)

In May-June this year two significant gas and oil discoveries were made on the seaboard of the State of Western Australia, by an operating company, which in the past eleven years has spent over £A20 million and drilled about 100 wells in the search for petroleum in the State. Yardarino No. 1 well, in the Perth Basin, produced large volumes of wet gas with some condensate on test. A 36° A.P.I. paraffinic oil was also recovered from the lower portion of the reservoir which is in the Permian sequence. Five wells drilled earlier in the Basin had only slight indications of hydrocarbons in the Mesozoic sequence. Of these, Eneabba No. 1, had a strong but short-lived flow of wet gas at about 12,800 feet.

To the north, in the Carnarvon Basin, a well drilled on Barrow Island had a flow of several million cubic feet per day of wet gas and some condensate on a drillstem test in June, 1964. On a later drillstem test of the lower sand reservoir, the well flowed several hundred barrels of 38° A.P.I. oil per day. The second well, Barrow No. 2, is now drilling; on a drillstem test of 6124' - 6167' interval this well produced 10 MMcf/d of wet gas. (283,200 m^3).

The whole island, which has an area of about 144 square miles, constitutes a surface anticlinal structure, which has been shown by reconnaissance seismic survey to continue at depth. The full size of the structure has not been established as yet, and it is thought that it may extend outside the Island.

Further to the north-east, in a well in the Bonaparte Gulf Basin, a flow of gas at a rate of 1.54 MMcf/d (43,613 m^3) was measured in September, 1964 during a drillstem test of the 4712' - 4819' interval in the Milligan Beds of Lower Carboniferous age.

Types of Gas.

The types of natural gas occuring in the accumulations referred to in the previous chapter are shown in the relevant column in Table 1.

At this early stage of natural gas development in Australia it is not possible to be sure in every case whether the gas is associated with oil or not. In the Bowen-Surat Basin, Queensland, it certainly is associated with the oil now being produced from the wells of the Moonie oilfield, and in the two completed oil wells on the Alton structure. Gas may also be associated with the oil found in some wells on the Richmond, Sunnybank and Snake Creek structures. It does not appear to be associated with oil elsewhere in the known accumulations in the Basin.

In the Carnarvon and Perth Basins, Western Australia, the gas appears to be associated with oil either in the form of gas cap or in solution or both.

The Gidgealpa accumulation in the Eromanga Basin, Queensland and South Australia and Mereenie in the Amadeus Basin, Northern Territory, appear at this stage to be wet gas accumulations only.

Reserves.

Except for the Roma area of the Bowen-Surat Basin, Queensland the Australian gas reserves are as yet unproven.

TABLE 1.

INDICATED NATURAL GAS & CRUDE OIL

PRODUCTION POTENTIAL OF WELLS IN AUSTRALIA

AS AT 30TH SEPTEMBER, 1964

Basin	Operating Company	Well Name & No.	Year Drilled	T.D. (feet)	Productive Interval (feet)	Formation	Age	Type of Test	Gas Flow Rate (MMcf/d)	Choke (inch)	Type of Gas & Liquid Hydrocarbons	Present Status
					QUEENSLAND							
Bowen-Surat	Amalgamated Petroleum Exploration Pty. Ltd.	Back Creek No.1	1964	5297	4750 - 4793	Evergreen "Shale"	L.Jur.	D.S.T.	1.75	3/16 Bot. 3/4 Top	Wet	S.I.P.
		Back Creek No.2	1964	5056	4812 - 4876	" "	"	D.S.T.	0.85	1/8 Top	Wet	P. & A.
		Snake Creek No.1	1964	5270	4969 - 5079	Showground Sandstone	Trias.	D.S.T.	4.6 6.0(Frac)	O.F.P.	Wet w. some condensate.	S.I.P.
		Snake Creek No.2	1964	5178	5028 - 5068	" "	"	D.S.T.	12.5	O.F.P.	Wet + 138 b/d condensate.	S.I.P.
		Snake Creek No.4	1964	4990	4955 - 4971 4976 - 4989	Rewan Rewan/ Showground Sst.	" "	D.S.T. D.S.T.	2.7 0.235	O.F.P. 1/2 Bot. 3/4 Top	Wet Wet + 10 b/d 45° A.P.I. Oil	S.I.P. S.I.P.
	Associated Australian Oilfields N.L.	Hospital Hill No.4	1954	3891	3693 - 3714	Hospital Hill Sandstone	Trias.	Prod.	0.87	3/4 Bot.	Wet	P. (Gas)
		Raslie No.1	1964		3700 - 3773	?	Jur.	D.S.T.	4.1	1/2 Bot.	Wet	Testing
		Beaufort No.1	1964	3836	3655 - 3836	Precipice Sst./ Mooleyember	L.Jur/ Trias.	D.S.T.	0.91	1/2 Bot. 3/4 Top	Wet	S.I.P.
		Beaufort No.2	1964	3799	3669 - 3849	" "	"	D.S.T.	0.7	?	Wet	S.I.P.
		Beaufort No.3	1964	3820	3617 - 3820	" "	"	D.S.T.	0.824	1/2 Bot.	Wet	S.I.P.
		Timbury Hills No.2	1960	4400	3697 - 3733	Mooleyember	"	D.S.T.	1.25	?	Wet	P. (Gas)
		Yanalah No.1	1964	4136	3731 - 3983	Precipice/ Mooleyember	Jur./ Trias.	D.S.T.	3.2	5/8 Bot. 1/2 Top	Wet	S.I.P.
		Yanalah No.3	1964	4740	3761 - 3781	"	"	D.S.T.	1.4	1/2 Bot.	Wet	S.I.P.
		Pickanjinnie No.1	1960	5213	4009 - 4028 4044 - 4053	Hospital Hill Sst./Mooleyember	"	D.S.T.	6.541	?	Wet	S.I.P.
		Pickanjinnie No.3	1964	4594	4220 - 4284	"	"	D.S.T.	2.5	1/2 Bot.	Wet	S.I.P.
		Pickanjinnie No.4	1964	4589	4078 - 4102	"	"	D.S.T.	5.0	1/2 Bot.	Wet	S.I.P.
		Pickanjinnie No.6	1964	4655	4082 - 4109 4220 - 4250	"	"	D.S.T. D.S.T.	5.6 7.5	1/2 Bot.	Wet	S.I.P.
		Apple Grove No.1	1963	4144	3919 - 3989	Precipice Sst.	L.Jur.	D.S.T.	1.64	1/2 Bot.	Wet	S.I.P.
		Richmond No.1	1963	4130	4005 - 4013	"	"	Prelim. Prod.	0.12	1/2 Top	Wet + 750 b/d Oil	S.I.P.(Oil)
		Richmond No.5	1963	4374	4155 - 4190	"	"	D.S.T.	0.5	1/2 Bot.	Wet + 250 b/d Oil	S.I.P.(Oil)
		Richmond No.7	1963	4200	4071 - 4198	"	"	D.S.T.	6.0	1/2 Bot.	Wet + some condensate	S.I.P.
		Richmond No.8	1963	4201	4071 - 4102 4110 - 4131	"	"	D.S.T.	3.5 1.25	1/2 Bot.	Wet	S.I.P.
		Richmond No.10	1964	4272	4067 - 4137	"	"	D.S.T.	9.0 0.65	1/2 Bot.	Wet Wet + 220 b/d Oil	S.I.P.
		Richmond No.11	1964	4270	4019 - 4105	"	"	D.S.T.	1.5	1/2 Bot.	Wet	S.I.P.
		Richmond No.13	1964	4343	4098 - 4151	"	"	D.S.T.	8.1	5/8 Bot. 1/2 Top	Wet + 80 b/d condensate	S.I.P.
		Richmond No.16	1964	4202	3993 - 4446	"	"	D.S.T.	4.25	3/8 Bot.	Wet + condensate	S.I.P.
		Richmond No.18	1964	4165	3920 - 4165	"	"	D.S.T.	5.25	1/2 Bot.	Wet + condensate	S.I.P.
		Blyth Creek No.1	1964	3998	3786 - 3820	"	"	D.S.T.	8.1	5/8 Bot. 3/8 Top	Wet + some condensate	S.I.P.
		Blyth Creek No.2	1964	3973	3763 - 3812	"	"	D.S.T.	2.0	?	"	S.I.P.

Table 1

QUEENSLAND (Continued)

	Bony Creek No.1	1963	4583	4306 - 4346	Precipice Sst.	L. Jur.	D.S.T.	2.35	O.F.P.	Wet	S.I.P.
	Bony Creek No.2	1963	4646	4238 - 4290	"	"	D.S.T.	3.5	½ Bot.	Wet	S.I.P.
	Bony Creek No.4	1963	4500	4290 - 4500	"	"	D.S.T.	2.5	½ Bot.	Wet	S.I.P.
	Bony Creek No.5	1963	4343	4233 - 4343	"	"	D.S.T.	5.0	½ Bot.	Wet	S.I.P.
	Bony Creek No.6	1963	4510	4310 - 4510	"	"	D.S.T.	4.6	½ Bot.	Wet	S.I.P.
	Bony Creek No.9	1964	4337	4285 - 4337	"	"	D.S.T.	0.5	½ Bot.	Wet	S.I.P.
	Bony Creek No.10	1964	4446	4317 - 4374	"	"	D.S.T.	4.5	½ Bot.	Wet	S.I.P.
	Bony Creek No.12	1964	4489	4285 - 4312	"	"	D.S.T	5.6	½ Bot.	Wet & some condensate	S.I.P.
	Bony Creek No.13	1964	4360	4226 - 4360	"	"	D.S.T	6.5	½ Bot.	"	S.I.P.
	Sunnybank No.1	1962/63	7134	5860 - 5925	Pickanjinnie	L.Trias	D.S.T.	0.3	⅝ Bot.	Wet + 600 b/d oil	S.I.P.(Oil?)
				6432 - 6468	Bandanna	U.Perm.		0.267	⅝ Bot.	Wet	
	Glentulloch No.1	1961	4868	2494 - 2530	Early Storms	Perm.	D.S.T.	11.750)	5/16 Bot.	Dry (about 11% CO_2)	S.I.P.
				2579 - 2720	E.S.& Staircase			2.485)	¾ Top		
				2727 - 2809	Staircase			2.924)			
	Westgrove No.2	1962	5550	2807 - 2840)	Early Storms	Perm.	Prod.	4.75	O.F.P.	Dry (about 23% CO_2)	S.I.P.
				2919 - 2929)	Sst.						
	Westgrove No.3	1962/63	12663	(2748 - 2802)	"	"	D.S.T.	0.541	5/16 Bot.	Dry (25.1% CO_2)	S.I.
				(2855 - 2911)				0.852	5/16 Bot.	Dry (30.6% CO_2)	
				(12303 - 12360)				0.293	⅜ Bot. ¼ Top	Dry (about 20% N_2)	
Associated Freney Oil Fields N.L.	Rolleston No.1	1963/64	9508	1836 - 1902	Mantuan Bd.	Perm.	D.S.T.	1.38	½ Bot. ¾ Top	Dry	
				2945 - 2980	Early Storms			43.0	O.F.P.	Wet + condensate	S.I.P.
	Rolleston No.3	1964	3250	1940 - 2010)	"	"	D.S.T.	0.5	½ Bot.	Dry	S.I.P.
				3024 - 3072)				3.25	½ Bot.	Wet	
	Rolleston No.8	1964	3400	1940 - 2066	Mantaun Rd.	Perm.	D.S.T.	1.0	½ Bot.	Dry	S.I.P.
	Arcturus No.1	1964		1750	?	Perm.	?	5.0 (estim.)	O.F.P.	?	Blowout
Union Oil Development Corporation	Cabawin No.1	1960/61	12035	9925 - 10172	Kianga	Perm.	Prod.	0.53	?	Wet + 62b/d condensate	S.I.P.
	Moonie No.1	1961	6106	5808 - 5840	Precipice Sst.	L. Jur.	D.S.T.	1.75	½	Wet + 1765 b/d oil	P. (Oil)
	Moonie No.2	1962	6289	5640 - 5661	"	"		0.55	½	Wet + 376 b/d oil	
				5651 - 5675	"	"	D.S.T.	1.97	1	Wet + 2692 b/d oil	P. (Oil)
	Moonie No.3	1962	6021	5795 - 5827	"	"		2.40	½	Wet + 1392 b/d oil	
	Moonie No.4	1962	6005	5805 - 5877	"	"	D.S.T.	?	½	1500 b/d oil	P. (Oil)
	Moonie No.5	1962	5990	5804 - 5826	"	"	D.S.T.	1.95	½	Wet + 1575 b/d oil	P. (Oil)
	Moonie No.6	1962	6502	5805 - 5843	"	"	D.S.T.	1.60	½	Wet + 1645 b/d oil	P. (Oil)
	Moonie No.7	1962	5953	5814 - 5837	"	"	D.S.T.	1.0	½	Wet + 1660 b/d oil	P. (Oil)
	Moonie No.8	1962	6031	5802 - 5835	"	"	D.S.T.	2.6	½	Wet + 1625 b/d oil	P. (Oil)
				Prod. test on completion of well	"	"	Prod.	0.5	½	Wet + 360 b/d oil	P. (Oil)
	Moonie No.9	1962	5942	5800 - 5831	"	"	D.S.T.	1.2	½	Wet + 1130 b/d oil	P. (Oil)
	Moonie No.10	1962	5970	5827 - 5832	"	"	D.S.T.	1.5	½	Wet + 924 b/d oil	P. (Oil)
	Moonie No.11	1962/63	5817	Prod. test on completion of well	"	"	Prod.	1.75	½	Wet + 1642 b/d oil	P. (Oil)
	Moonie No.13	1963	6918	"	"	"	"	?	?	240 b/d oil	P. (Oil)
	Moonie No.14	1963	6124	"	"	"	"	1.34	½	Wet + 960 b/d oil	P. (Oil)
	Moonie No.15	1963	5944	"	"	"	"	1.2	22/64	Wet + 768 b/d oil	P. (Oil)
	Moonie No.17	1963	6010	5644 - 5664	"	"	D.S.T.	1.56	26/64	Wet + 825 b/d oil	P. (Oil)
				5780 - 5822	"	"	D.S.T.	2.13	½	Wet + 1066 b/d oil	P. (Oil)
	Alton No.1	1964	7328	6064 - 6124	Evergreen "Shale"	Jur.	Prod.	0.207	22/64	Wet + 480 b/d oil	S.I.P. (Oil)
	Alton No.2	1964	6139	6085 - 6104	"	"	Prod.	0.943	36/64	Wet + 2000 b/d oil	S.I.P. (Oil)
	Conloi No.1	1964	6005	4313 - 4321	"	Jur.	Prod. (Pumping)	Small	?	400 b/d oil	S.I.P. (Oil)

QUEENSLAND (Continued) Table 1.

Adavale	Phillips Petroleum Company & Sunray DX Oil Company	Gilmore No. 1	1964		11940 - 12124	Etonvale Sandstone	Dev.	D.S.T. 5.37	$\frac{5}{8}$ Bot. $\frac{1}{4}$ Top.	Dry	Drilling
					NEW SOUTH WALES						
Sydney	Australian Oil & Gas Corporation Ltd.	Camden No. 7	1959	1690	1350 - 1690		Trias.	O.H. 1.0	O.F.P.	Dry	S.I.
					VICTORIA						
Otway	Frome-Broken Hill, Co.Pty.Ltd.	Port Campbell No. 1	1959	5965	5656 - 5668	Waarre	L.Cret.	Prod. 4.15	O.F.P.	Wet + some condensate	P. & A.
					SOUTH AUSTRALIA						
Eromanga	Delhi Australian Petroleum Ltd.	Gidgealpa No. 2	1964	9020	6756 - 6779) 6792 - 6804) 6836 - 6842) 6857 - 6871)	Not named	Perm.	Prod. 11.6 (40.0 O.F.P)	$\frac{1}{2}$	Wet + 42 b/d condensate	S.I.P.
		Gidgealpa No. 3	1964	10934	(7311 - 7330 (7528 - 7562	"	"	" 2.0	$\frac{1}{4}$	Wet + some condensate	S.I.P.
		Gidgealpa No. 4	1964	7783	6879 - 7041) 7194 - 7246)	"	"	" 16.15	$\frac{1}{2}$	Wet + 144 b/d condensate	S.I.P.
		Gidgealpa No. 5	1964	8763	7090 - 7193	"	"	" 5.725	$\frac{1}{2}$	Wet + 305 b/d condensate	S.I.P.
					WEST AUSTRALIA						
Perth	West Australian Petroleum Pty.Ltd.	Yardarino No. 1	1964	7800	7485 - 7526) 7542 - 7622)	Wagina	Perm.	D.S.T. 15.3 D.S.T. 3.5	$\frac{5}{8}$ Bot. Adj. Top 3/16 Bot. $\frac{1}{2}$ Top	Wet + condensate Wet	S.I.
Carnarvon	West Australian Petroleum Pty.Ltd.	Barrow No. 1	1964	9785	6176 - 6681 (3 intervals)	Not named	Jur.	D.S.T. ±14.0	9/16 Bot. Adj. Top	Wet	S.I.P.
					6750 - 6783	"	"	Prod. 1.18	$\frac{1}{2}$ Top	Wet + 985 b/d Oil	
		Barrow No. 2	1964		6124 - 6167	"	"	D.S.T. 10.0	$\frac{5}{8}$ Bot. $\frac{1}{2}$ Top	Wet	Drilling
					6191 - 6200	"	"	D.S.T. 3.5	$\frac{5}{8}$ Bot. $\frac{1}{4}$ Top	Wet with some oil	
Bonaparte Gulf	Alliance Oil Development Australia N.L.	Bonaparte No. 2	1964		4712 - 4819	Milligan Beds	L.Carb. - Dev.	D.S.T. 1.54	9/16 Bot. Adj. Top	Dry	Drilling
					NORTHERN TERRITORY						
Amadeus	Exoil (N.T.) Pty.Ltd.	Mereenie No. 1	1964	3983	2671 - 2724) 3130 - 3212)	Stairway Sandstone	Ordov.	D.S.T. 0.35 D.S.T. 0.295	$\frac{5}{8}$ Bot. $\frac{5}{8}$ Bot.	Wet Wet	}
					3486 - 3983	Pacoota Sandstone	Ordov.	D.S.T. 4.8 (O.F.P 11 MMcf/d)	$\frac{5}{8}$ Bot.	Wet + condensate	P. & A.
		East Mereenie No.1	1964	4710	2578 - 2703) 3079 - 3155)	Stairway Sandstone	Ordov.	D.S.T. 0.31 0.26	Nil Nil	Wet Wet	
					3669 - 4606 (Several intervals)	Pacoota Sandstone	Ordov.	D.S.T. 30.0 (O.F.P over 50 MMcf/d)	Nil	Wet + condensate	S.I.P
		East Mereenie No.2	1964		3832	Stairway Sandstone	Ordov.	D.S.T. 0.31	O.H. O.H.	Wet	
					4145 - 4187	Pacoota Sandstone	Ordov.	D.S.T. 3.1	$\frac{5}{8}$	Wet + condensate	Drilling

Abbreviations used in this tabulation:

T.D.	-	Total depth
D.S.T.	-	Drillstem test
O.F.P.	-	Calculated Open flow potential
O.H.	-	Open hole
S.I.	-	Shut-in
S.I.P.	-	Shut-in for production
P.	-	Producing
P. & A.	-	Plugged and abandoned
b/d	-	Barrels per day
MMcf/d	-	Million cubic feet per day

Note: 1 cubic foot = 0.02832 m^3

1 barrel = 5.6146 cubic feet = 0.159 m^3

The reserves of the Roma area quoted as "proven" by the operating group of companies (Associated Group) are given at about 125,000,000,000 (125 billion) cubic feet (3,400,000,000 m^3) and with further drilling may increase to more than 200 billion cubic feet. (5,610,000,000 m^3). They are contained in small to medium-sized structures and reservoirs with erratic permeabilities; the rates of gas flow from these reservoirs vary greatly over short distances.

The reserves of the Bowen Sub-Basin (Westgrove, Glentulloch, Rolleston, Arcturus and further north) are probably not as large as those of the Roma area, but in order to obtain any reliable estimate, much more drilling is required; the Permian gas is dry and in addition contains a relatively high proportion of carbon dioxide and, in some parts also nitrogen.

Reserves of gas largely dissolved in oil in the Moonie oilfield are not great; in any case, the gas there may be used for repressuring at a later stage of oil production.

There may be significant reserves of gas in the Adavale Basin, as indicated by Gilmore No. 1, which is located on a structure covering several square miles in which the Devonian sandstone reservoirs are over 130 feet thick.

The probable gas reserves in the Gidgealpa structure in the Eromanga Basin are, on present indications, of the order of many hundreds of billions of cubic feet while those in the Mereenie structure in the Amadeus Basin may be even larger. Drilling is continuing on both these structures. It should be noted that in both these areas there are many other structures, undrilled as yet, which appear to have petroleum potential comparable with that of Gidgealpa and Mereenie.

The probable reserves of the Barrow Island structure in the Carnarvon Basin are comparable with those of Gidgealpa and Mereenie, but structural and stratigraphic complications of the Yardarino area in the Perth Basin do not permit any degree of confidence as to the probable size of gas reserves therein.

State of Development of the Search for Natural Gas Accumulations.

With two exceptions, there has been no deliberate search for natural gas accumulations in Australia, but recent discoveries have highlighted the extent of gas reserves and have emphasised the importance of them, within the scope of a wider search for petroleum reserves, in a dramatic fashion.

The two exceptions include the search for natural gas in the Sydney Basin carried out without much success for many years by the Australian Oil & Gas Corporation, and in the Bowen-Surat Basin by the Associated Group* with considerable success. The companies of the Associated Group have been primarily searching for oil accumulations, but have found mostly gas. Presently, they are engaged in developing and assessing their finds. At the same time they are carrying out an exploration programme in the Basin in order to increase the reserves of gas and, perhaps, oil. Similarly, drilling programmes are being actively pursued at Gidgealpa and neighbourhood, at Mereenie, Yardarino and Barrow Island. Further drilling is to be carried out shortly on other structures in the Amadeus Basin, in the Bonaparte Gulf Basin and in the Adavale Basin. These programmes, as regards natural gas, are to establish reserves large enough for any commercial utilization. Some of them, if not all, are also meant to assess and develop oil shows so far encountered as well as to discover new ones.

The abovementioned areas are the "hot spots" of petroleum exploration in Australia. However, exploration activity is going on in almost every sedimentary basin on land and preliminary geophysical exploration is also being carried out on the continental shelf around Australia. A wildcat is to be spudded-in shortly off the south eastern coast of Victoria in the Gippsland Basin. Generally, exploration activity has been gathering momentum every year.

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* Associated Australian Oilfields N.L.,
Associated Freney Oil Fields, N.L.,
The Papuan Apinaipi Petroleum Company Ltd.,
Associated Continental Petroleum N.L.
Interstate Oil Ltd.
Sleigh Exploration N.L.

The most important factor in this growing exploration effort and some of the successes that followed has been the Federal Government's policy of providing assistance to the explorers, by way of subsidies for various kinds of drilling and geophysical surveys, by income tax relief and by carrying out regional geological and geophysical surveys, some stratigraphic drilling and laboratory investigations and associated services and aerial and topographic mapping. The Geological Surveys of the respective States also contribute within their limits to the exploration effort.

The subsidizing of petroleum exploration has been carried out since the end of 1957 under the Petroleum Search Subsidy Act and its amendments of 1958, 1959, 1961 and 1964.

Tables 2, 3 and 4 below show the magnitude of exploration activity in Australia in the last few years.

Table 2

Total Expenditure (1958-1963) on Petroleum Exploration

($(U.S.) Million)

Year	Company (net)	Government (incl.subsidy)	Total
1958	12.32	1.57	13.89
1959	12.99	2.91	15.90
1960	13.88	4.03	17.91
1961	14.56	5.15	19.71
1962	28.00	12.32	40.32
1963	32.75	11.78	44.53

Table 3

Drilling Activity (1958-1963)

Year	Wells Completed	Wells Uncompleted	Aggregate Footage
1958	32	6	89,849
1959	54	8	120,397
1960	24	8	99,029
1961	20	9	128,830
1962	70	16	408,511
1963	125	22	663,942
1964			
1st Qtr.	48	17	227,407
2nd Qtr.	56	18	287,228
3rd Qtr.	52	20	270,870

Table 4. Exploration by Party Months (1959-1963)

Year	Air-Photo	Geological	Seismic	Gravity	Magnetic
1959	3.0	223.75	41.45	62.35	9.0
1960	-	143.87	92.25	29.12	16.15
1961	13.25	218.75	163.75	33.75	33.75
1962	100.50	297.50	311.25	49.00	39.25
1963	110.25	329.75	313.00	120.25	10.25 + 148,618 line - miles of aero-magnetics.

Legislation

The legislation covering exploration and development of petroleum resources in Australia is liberal and non-restrictive. Each State and Territory has its own petroleum legislation administered by the respective Department of Mines. There is no separate legislation for natural gas, and the provisions of the existing Petroleum Acts, Ordinances and Regulations apply to both oil and gas, unless a distinction is specifically made between them. Most of these Petroleum Acts. etc. contain provisions dealing to some extent with conservation matters. Recently one State (Queensland) has decided to appoint a petroleum conservation engineer to its Department of Mines.

PRODUCTION OF NATURAL GAS.

At this early stage of development there is practically no natural gas production in Australia. However, relatively small amounts of gas from Timbury Hills No. 2 and Hospital Hill No. 4 wells have been sold since 1961 to the Roma Power Station as shown below:

Year	Liquids ('000 litres)	Gas ('000 m^3)
1961	2.548	345.10 (six months only)
1962	10.000	1596.14
1963	19.544	2711.24
1964	12.592	1465.87 (six months)

Recently, eight miles of 4-inch pipeline were laid from Richmond field to the new power house at Roma in order to supplement the present gas deliveries and to provide for any foreseeable increase in demand.

The price at which gas is sold at present is around 6 shillings (Aust.) ($(U.S.) 0.67) per 1000 cu. ft.

TRANSPORTATION OF NATURAL GAS

At least two gas pipelines are contemplated and a third one is a possibility.

Gidgealpa-Adelaide Pipeline

Perhaps, the best chances of economic success and early completion exist for the pipeline from Gidgealpa to Adelaide, a distance of some 500 miles (805 kilometers) with possible branches to Broken Hill, to Point Pirie and to Whyalla. An extension to the Mt. Gambier area on the border of South Australia and Victoria is possible at a later stage. This is shown in a schematic fashion in Figure 1.

An 18-inch pipeline from Gidgealpa to Adelaide, including also field gathering lines, compressor stations etc. is estimated to cost about £A19 million ($ 43 (U.S.) million). A preliminary market study has been completed by an American consulting firm. Also, preliminary approaches to probable major consumers have been made, and as soon as adequate reserves are proven, the pipeline would be constructed. It may be completed near the end of 1966. The companies concerned in the development of the Gidgealpa field, Santos Limited and Delhi Australian Petroleum Ltd. have also engaged a firm of consultants to carry out a reservoir engineering study of the field.

Roma-Brisbane Pipeline

As mentioned earlier in this paper the proven reserves of natural gas in the Roma area of the Bowen-Surat Basin are said to be 125 MMM c.f. or 3,440,000,000 m^3, and the Associated Group consider them adequate for the construction of a 10-inch, 270-miles (about 434 kilometers) gas pipeline from Roma to Brisbane.

At this moment the Group is engaged in the feasibility studies of such a pipeline. No other reliable details concerning the project are available. It is known, however, that the Group has been conducting negotiations with two major coal gas companies operating in Brisbane and its environs for the sale and distribution of natural gas from Roma fields.

Mereenie-Eastern States Pipeline

The probable gas reserves in the Mereenie structure are thought to be sufficiently large to make it worthwhile giving consideration to Sydney and/or Melbourne metropolitan areas, to see whether they could offer the large markets required to make this long haul, and consequently large diameter pipeline, economically attractive.

The distances which would be involved are roughly 1400 miles (2250 km) to Sydney and 1250 miles (2000 km) to Melbourne. The sizes of pipeline involved would represent a capital investment of some £A.80-100 million ($U.S.180-220 million) for Sydney, and £A.70-90 million ($U.S. 160-200 million) for Melbourne.

Legislation

The installation and operation of gas pipelines in Australia would require supplementary legislation by the respective States; the existing petroleum legislation is inadequate in this respect, except perhaps in the State of Queensland, where "An Act to Amend the Petroleum Acts, 1923-1958", enacted in that State in December, 1962, contains "inter alia", suitable provisions for pipeline construction and operation, land acquisition, easements etc. The oil pipeline from Moonie to Brisbane was constructed under this amended Act, smoothly and with great efficiency.

Under the existing petroleum legislation in Australia, all crude oil and natural gas are subject to a royalty, payable to the State Government concerned, averaging 10% of the selling value.

Income tax relief is granted on capital investment for gas and oil pipeline construction.

General Characteristics

Apart from an insignificant amount at Roma, Queensland, no natural gas is sold in Australia as yet, nor has there been any firm commitment for sale of gas, in terms of announced pipeline construction.

The potential markets for natural gas in Australia are generally located in and around capital cities, relatively far removed from the natural gas accumulations so far discovered.

They also vary as to size in proportion to the size of population, industrial development and the availability of the more conventional forms of energy and chemical raw materials.

Thus the two largest potential markets relative to population size and industrial development are in the States of New South Wales and Victoria, but natural gas would be there in strong competition with the abundantly available black and brown coal and petroleum products of the refineries as well as large hydroelectric establishments like the Snowy Mountains Authority.

The Queensland market for natural gas is at a disadvantage not only on account of relatively small population and inferior industrial development but also due to the availability of large reserves of cheap sub-bituminous to bituminous coal, and petroleum products from two refineries due for completion in a year or two.

The South Australian potential market is relatively small as regards population and industrial development. Although lignite is available for electricity generation, the State has no worthwhile black coal deposits and is obliged to import black coal from other States. There would, however, be competition from the petroleum products from the Adelaide refinery.

A situation similar to that in South Australia exists in Western Australia except that the population and industry in the latter States is smaller.

Present consumption of town gas (in natural gas equivalents) in the Australian capital cities is as follows :

Sydney	-	32 MM cf/d or 900,000 m^3/d
Melbourne	-	28 MM cf/d or 800,000 m^3/d
Adelaide	-	7 MM cf/d or 200,000 m^3/d
Brisbane	-	4 MM cf/d or 110,000 m^3/d
Perth	-	2 MM cf/d or 55,000 m^3/d

However, gas flows of the order of some ten times greater than these would be required in each case in order to ensure economic operation of pipelines from the gas fields to these cities. It becomes clear, then, that some other major user would

have to be found before natural gas can become commercially viable (assuming that adequate reserves of gas are established). The only fuel consumer currently of this order of magnitude is the electricity generating industry. In this field heavy competition will be met from coal, petroleum products and hydroelectricity.

In this respect the South Australian and Western Australian markets appear to hold an advantage over the remaining three by virtue of the formers' deficiency in the indigenous coal supplies. In those two States the natural gas would be competing with petroleum products, mainly fuel oil. A much tougher competition, resulting in a slower rate of industrial market penetration by natural gas, is likely to be met in Victoria, New South Wales and Queensland. It will come from all three major energy sources, i.e. coal, petroleum products and hydroelectricity.

The production of fuel oil has been increasing in Australia for years now, and rebate is now offered on its sale price; in these circumstances a price war may be anticipated by the natural gas suppliers.

In the consideration of the potential markets for natural gas a look at the trend of primary energy consumption in Australia brings out some interesting observations (Figure 7).

In the last decade the total primary energy consumption has increased from 31×10^6 tons black coal equivalent to about 51×10^6 b.c.e. The average rate of increase was 4.9% per annum and is reasonably close to the estimated (in constant currency) rate of increase of Gross National Product of 5% per annum over the last five years. (The average rate of increase of primary energy consumption per head of population has been 3.0% per annum in the same five-year period).

The consumption of all types of coal has increased slowly, while the consumption of petroleum and hydroelectric power has more than doubled in the last ten-year period.

Most of the increase of primary energy consumption has been absorbed by petroleum.

The share of the total primary energy market taken by coal has been cut down by some 15% and petroleum's share rose by about 14% in the last ten years. Hydroelectricity's participation rose by about 3% of the total.

Possible Major Uses of Natural Gas in Australia

Unless natural gas fields can be discovered much closer to the major energy consuming areas than has hitherto been the case, it would appear that electricity generation and industrial markets in the metropolitan areas will have to be won by natural gas. Markets many times in excess of the current town gas markets would be necessary in order to take advantage of the low price which could be achieved by the use of large diameter, high throughput pipelines.

It can be envisaged that additional markets would build up in magnitude once the natural gas becomes available, especially if the price to the consumer could be reduced significantly from the present charges for town gas, which vary between 18 shillings to 40 shillings ($U.S.2.02-4.48) per 1000 cu. ft. of natural gas equivalent (10 therms or 252,000 kg. cal). Eventually it could be anticipated that natural gas would displace the use of electricity in many domestic and commercial heating applications.

The industrial sector of the potential market for natural gas as a fuel may be expected to grow at a rate of 4% to 5% per annum, which is the annual rate of growth of G.N.P. This growth is conditional on price of natural gas being competitive with fuel oil and coal.

In the field of electric power generation, the trend is to construct large capacity plants on the coal fields, in order to eliminate relatively high costs of transportation of coal. Because of the low coal costs achievable under this system it is doubtful whether natural gas could be transported from long distances at a price sufficiently competitive to meet this base-load requirement. However, in the location of peak-load plant adjacent to the large metropolitan markets, which are not so close to the coal-fields,

natural gas may be able to gain the advantage.

The current price of fuel for the generation of electricity varies between 4.25 pence per therm in Adelaide and 4.6 pence per therm in Brisbane. ($ U.S. 0.08 per 25,200 kg. cal to $ U.S. 0.086 per 25,200 kg. cal.). The respective wellhead prices at Gidgealpa and Roma calculated on the basis of the estimated capital costs and costs of operation and maintenance of plant and pipelines fall within the range of $ U.S. 0.0112 per 25,200 kg. cal and $ U.S. 0.012 per 25,200 kg. cal. or 1.0 pence per therm to 1.3 pence per therm.

These estimates of wellhead price are based on the assumption that the price obtainable at the market will be equal to that currently established by competition between coal and oil. It has been suggested, however, that natural gas may be able to command a premium of 10% or more above the price of solid and liquid fuels on the basis of cleanliness and convenience of use, but the effects of market competition are difficult at present to foresee. A higher price for natural gas might be obtainable from the industrial and commercial market than from electricity generating authorities.

Use of Natural Gas as Raw Material for the Chemical Industry

It would be premature at this stage to attempt a discussion of the possible use of natural gas as a raw material for chemical industry. The internal consumption and any extension thereof as well as exports appear to have been taken care of by the petroleum refining industry. It would be a very tough market for natural gas to penetrate, although the experience elsewhere in the world has shown that the availability of natural gas has eventually attracted a natural gas - based industry and other industrial ventures associated with it.

Acknowledgement: The author gratefully acknowledges the advice of Dr. W. T. McFadyen, Assistant Secretary, Fuel Branch, Department of National Development, in connection with the preparation of those parts of this paper dealing with transportation of and markets for natural gas in Australia.

AUSTRALIA

NATURAL GAS AND OIL DISCOVERIES

REFERENCE

- Gas well
- Abandoned gas well
- Oil well
- Oil field
- Abandoned oil well
- Oil and gas well
- Abandoned oil and gas well
- Existing oil pipeline
- Gas pipelines under consideration
- Possible extensions of gas pipelines under consideration

200 0 200 400

MILES

Darwin - Bathurst Island Mesozoic Sediments

DARWIN

BONAPARTE GULF BASIN

McARTHUR BASIN

BONAPARTE

DALY RIVER BASIN

ORD BASIN

FITZROY BASIN

CANNING BASIN

SOUTH CANNING BASIN

BARROW IS

ROUGH RANGE

NGALIA BASIN

MEREENIE

AMADEUS BASIN

CARNARVON BASIN

YARDARINO

PERTH BASIN

PERTH

OFFICER BASIN

EUCLA BASIN

SOUTH NICHOLSON BASIN

GEORGINA BASIN

GIDGEALPA

PIRIE - TORRENS BASIN

Whyalla

Pt. Pirie

Broken Hill

Devonian Sediments

ADELAIDE

ST. VINCENT BASIN

MURRAY BASIN

Mt. Gambier

OTWAY BASIN

PT. CAMPBELL

MELBOURNE

GIPPSLAND BASIN

GIPPSLAND SHELF

BASS BASIN

TASMANIA BASIN

HOBART

LAURA BASIN

CARPENTARIA BASIN

BUNDOCK CLARKE RIVER AND STAR BASINS

GREAT ARTESIAN BASIN

DRUMMOND BASIN

Upper Palaeozoic Sediments

STYX BASIN

BOWEN BASIN

YARROL BASIN

ARCTURUS

ROLLESTON

GILMORE

ADAVALE BASIN

WESTGROVE

WARINILLA

GLENTULLOCH

SURAT BASIN

ROMA AREA

CONLOI

SUNNYBANK

MOONIE

ALTON

ESK RIFT

BRISBANE

MARYBOROUGH BASIN

IPSWICH - CLARENCE BASIN

COONAMBLE BASIN

OXLEY BASIN

CORNE BASIN

Newcastle

SYDNEY BASIN

SYDNEY

CAMDEN

ROMA AREA

Beaufort

Yonalah

Raslie

ROMA

Pickanjinnie

Richmond

Bony Creek

Back Creek

Snake Creek

Blyth Creek

Note: Hospital Hill and Timbury Hills at Roma.

0 50

MILES

Bureau of Mineral Resources, Geology and Geophysics.

To accompany Record № 1964/170

X AUS-2-31

118° 124° 130° 136° 142° 148° 154°

112° 118° 124° 130° 136° 142° 148° 154° 160° 166°

14° 20° 26° 32° 38°

Fig.2

WELL LOCATIONS

Roma – Sunnybank Area

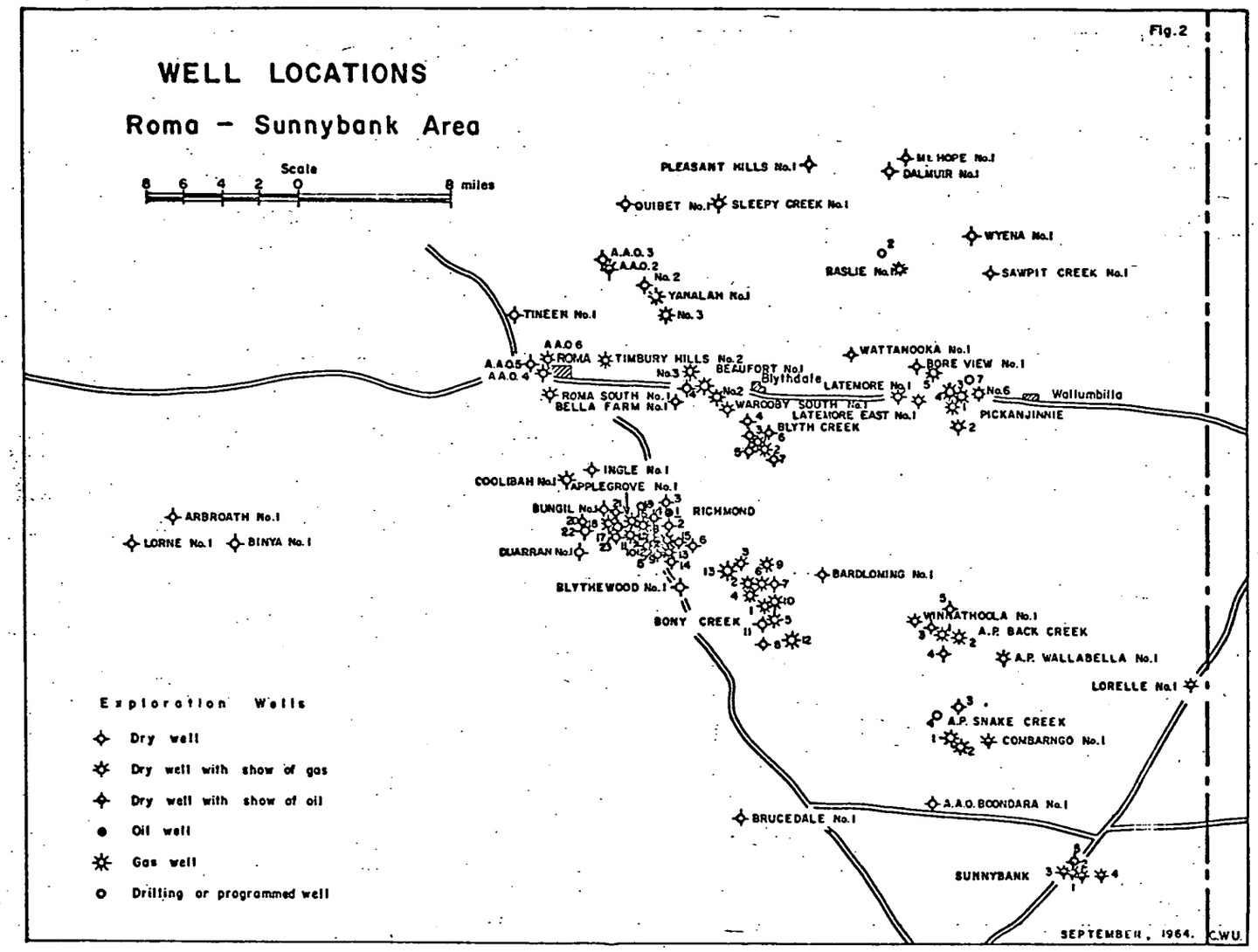


Fig. 3.

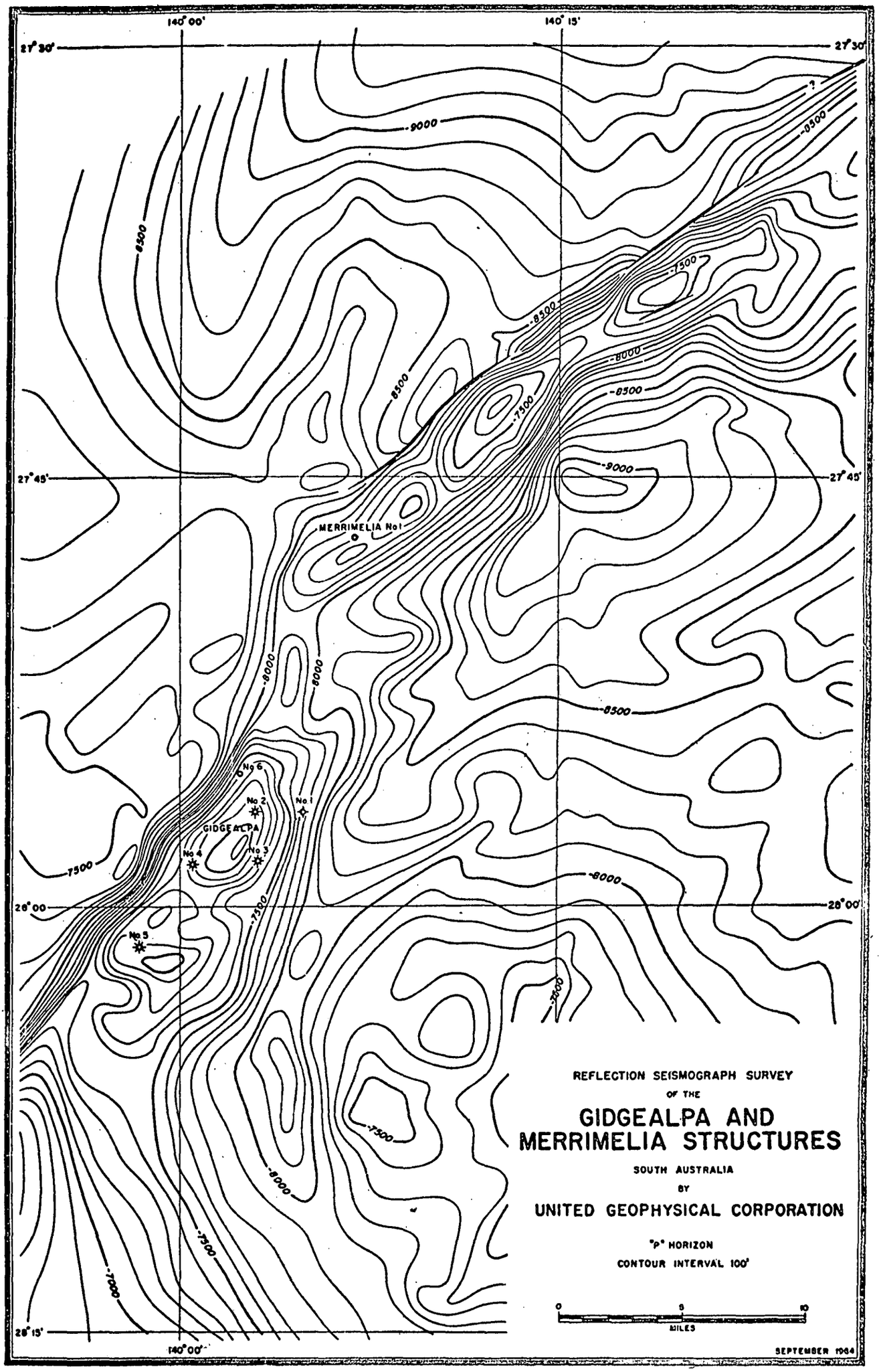
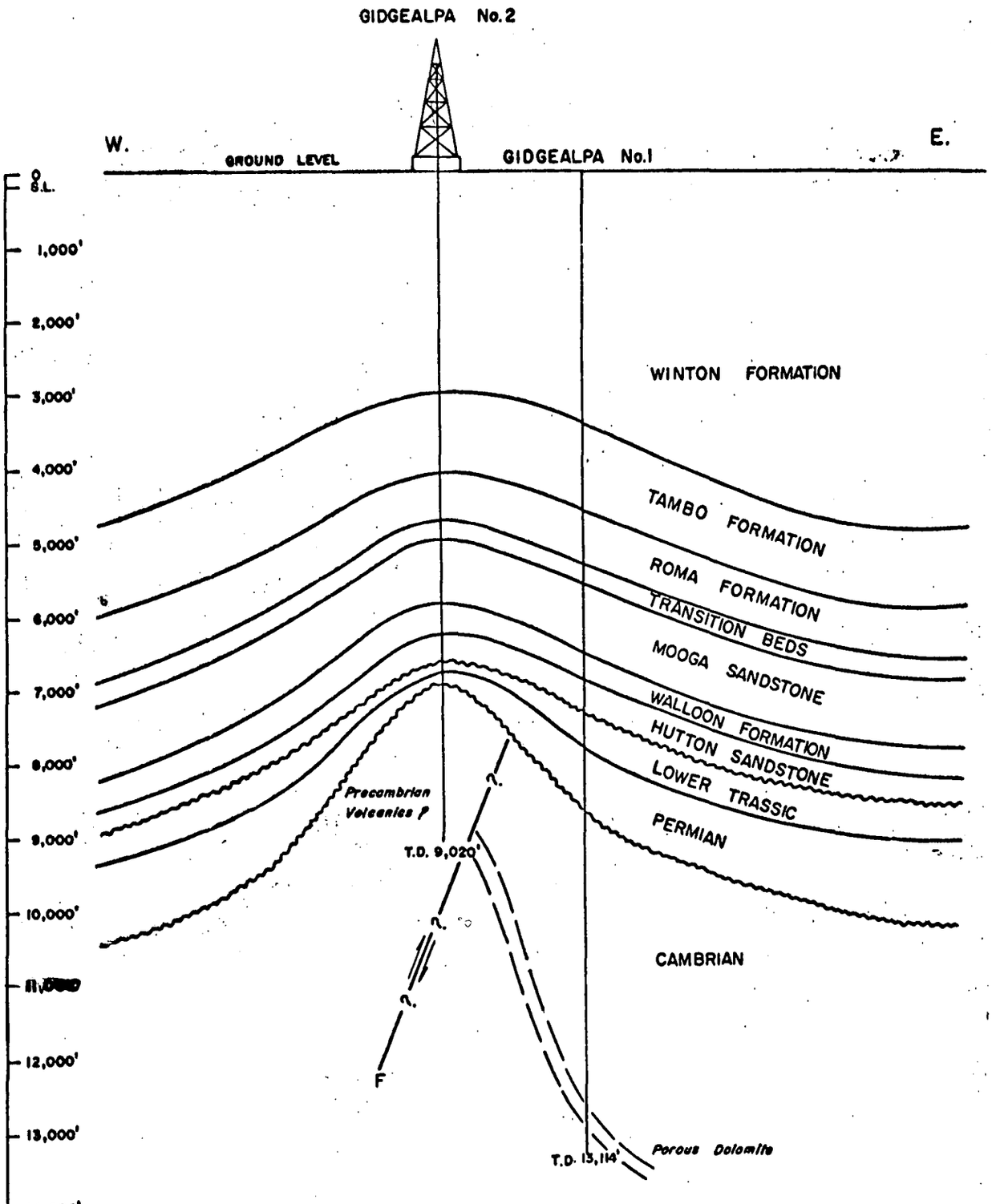

140° 00'
140° 15'
27° 30'
27° 45'
28° 00'
28° 15'
MERRIMELIA No 1
GIDGEALPA
No 1
No 2
No 3
No 4
No 5
No 6
-9000
-8500
-8000
-7500
-7000
REFLECTION SEISMOGRAPH SURVEY
OF THE
GIDGEALPA AND
MERRIMELIA STRUCTURES
SOUTH AUSTRALIA
BY
UNITED GEOPHYSICAL CORPORATION
"P" HORIZON
CONTOUR INTERVAL 100'
0
5
10
MILES
SEPTEMBER 1964

Fig. 4



DELHI AUSTRALIAN PETROLEUM LTD.

STRUCTURE AND STRATIGRAPHY

OF THE

GIDGEALPA ANTICLINE

AS INTERPRETED AFTER DRILLING

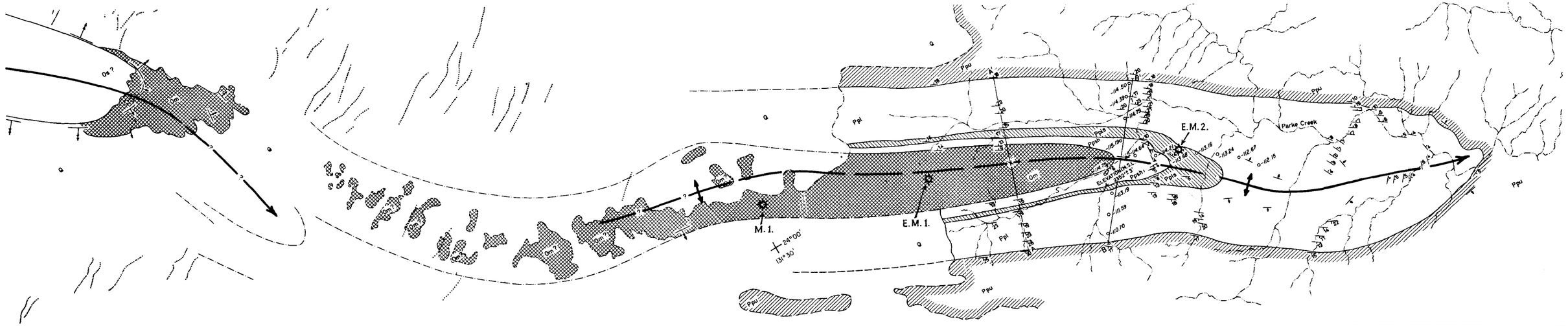
GIDGEALPA No. 2

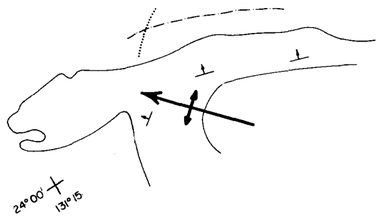
1 0 1 2 3 4 5

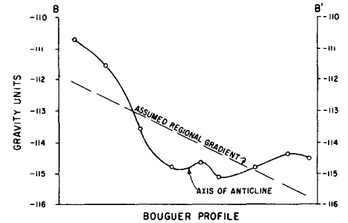
MILES

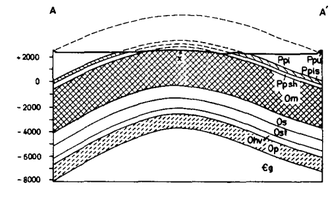
Bureau of Mineral Resources, Geology and Geophysics, October, 1964.

X AUS-2-28



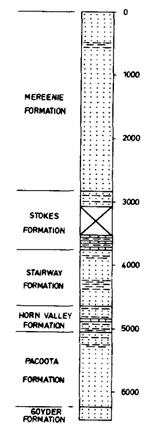






GEOLOGIC CROSS SECTION ALONG LINE A—A'
Note: Depths are approximate

Generalized Composite Columnar Section at Point 'X'



☼ Gas wells

MAGELLAN PETROLEUM CORPORATION
BRISBANE AUSTRALIA

GEOLOGIC MAP AND CROSS SECTIONS OF MEREENIE ANTICLINE

EXPLANATION

Quaternary
- Q — Recent deposits, mainly sand dunes

Upper Paleozoic
- Ppu — Upper Pertnjara formation, mainly sandstone
- Ppl / Ppls — Lower Pertnjara formation, chocolate brown shales, mudstones siltstones; green micaceous shales and white marls; Ppls: Lower Pertnjara sandstone member
- Ppsh — Basal Pertnjara shale member

Ordovician
- Om — Mereenie formation, white, well sorted, cross bedded sandstones
- Os — Stokes formation, shale, limestone and a few thin, fine grained ss's
- Ost — Stairway formation, fine grained sandstone and siltstone
- Ohv — Horn Valley formation, shale, limestone and a few thin, fine grained ss's
- Op — Pacoota formation, well sorted, medium grained sandstones

Cambrian
- €g — Goyder formation

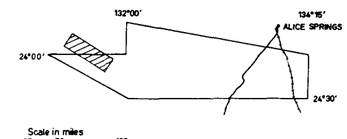
STRUCTURAL SYMBOLS

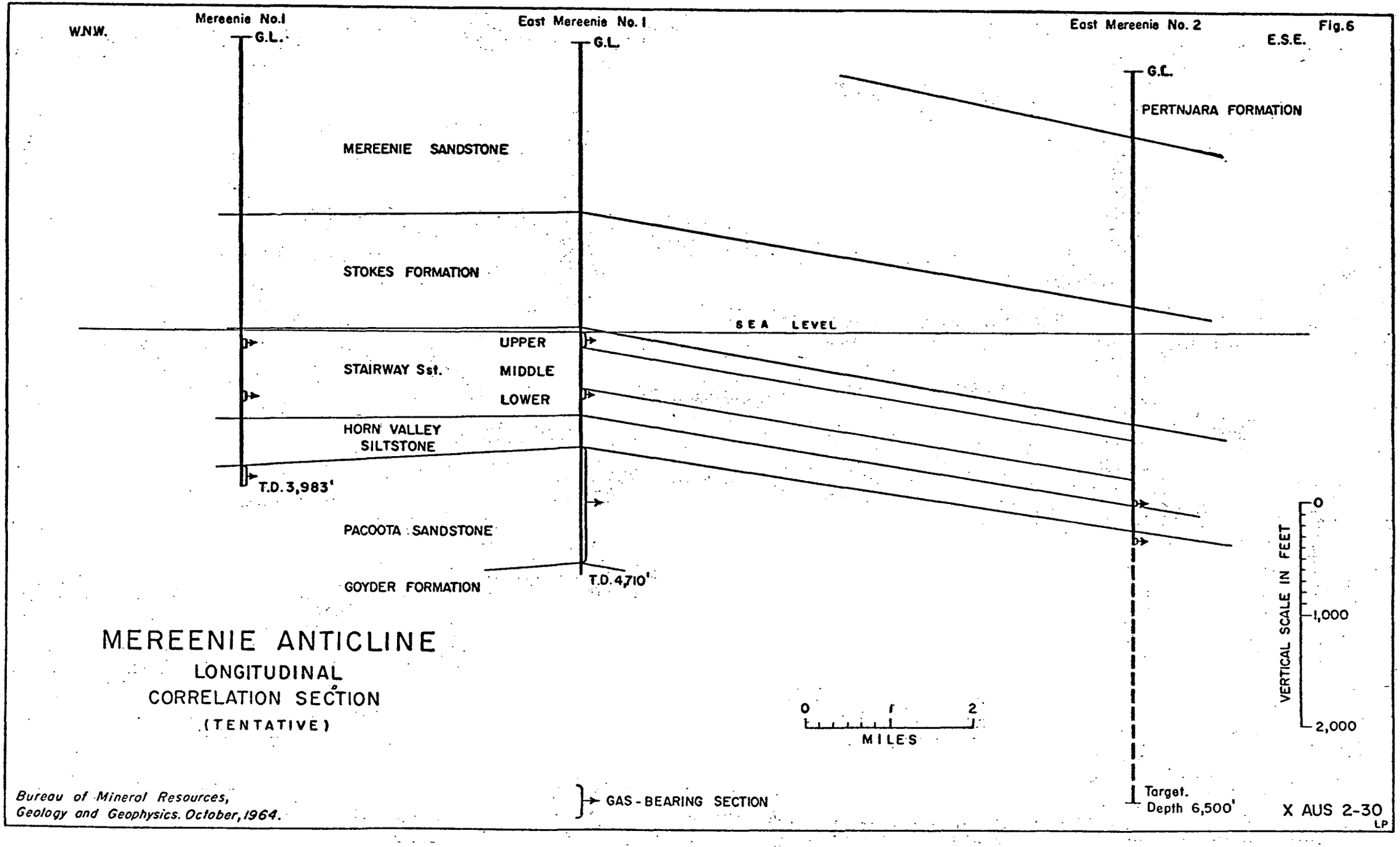
- Geologic contact, accurately located
- Geologic contact, approximately located
- Dip and strike
- Component dip
- Photo geologic attitude — dip less than 10°
- Photo geologic attitude — dip greater than 10°
- Obscure lineament mostly covered by sand dunes — may be geologic contact
- Anticlinal axis
- Sand dunes
- Intermittent stream
- -114.39 — Gravity station

SCALE
0 .5 1 1·5 2 3
miles

Geology by: D.A. McNaughton, R.M. Hopkins, Jnr.
Date: December 1961

INDEX MAP





MEREENIE ANTICLINE

LONGITUDINAL CORRELATION SECTION

(TENTATIVE)

Bureau of Mineral Resources, Geology and Geophysics. October, 1964.

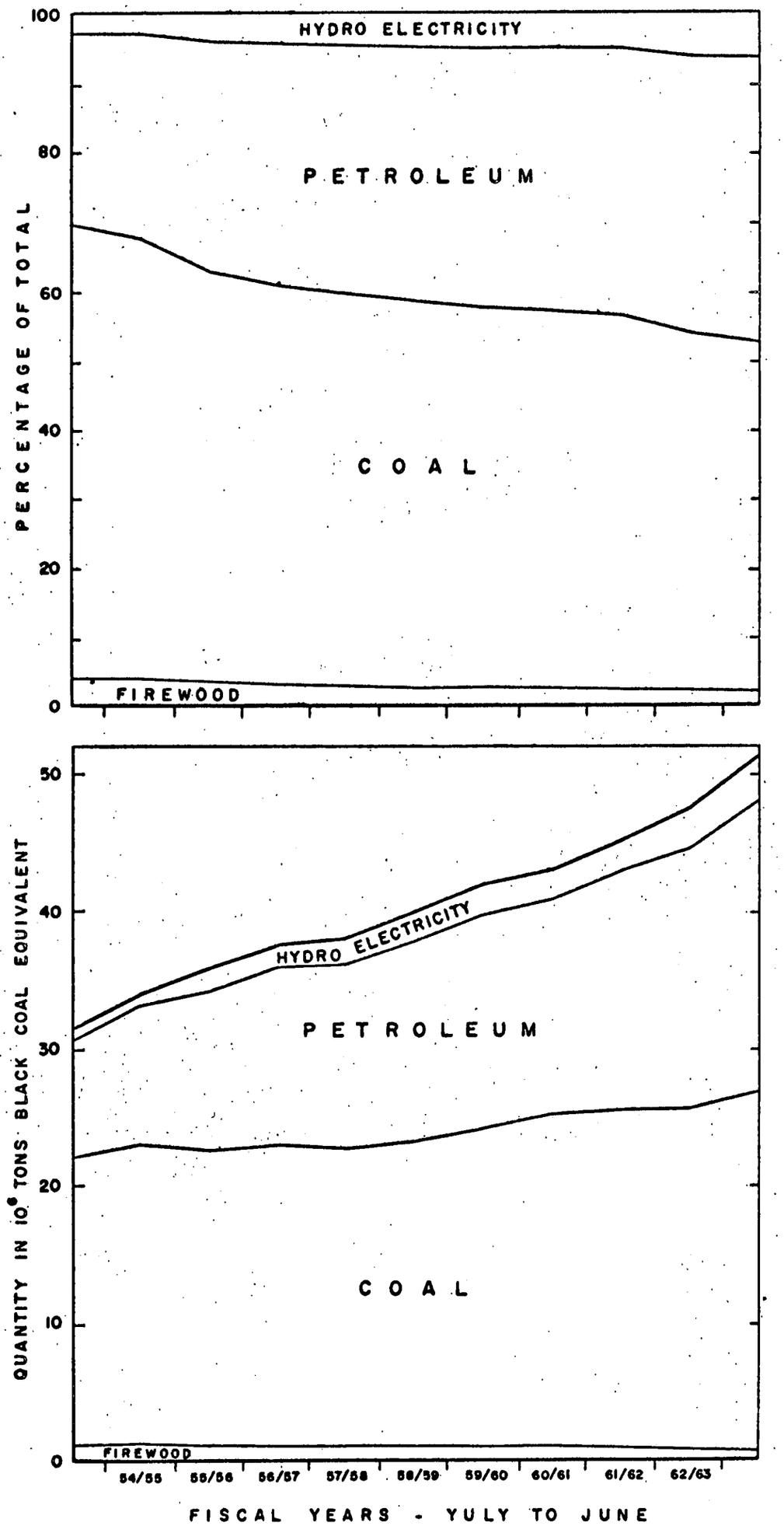
X AUS 2-30

LP

Fig. 7

AUSTRALIAN CONSUMPTION OF PRIMARY ENERGY

BASED ON FIGURES SUPPLIED BY THE JOINT COAL BOARD, SYDNEY.



Bureau of Mineral Resources, Geology and Geophysics. October, 1964.

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