BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

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AN ASSESSMENT OF THE TITHONIAN PLAY IN THE

DAMPIER SUB-BASIN AND RANKIN TREND,

OFFSHORE WESTERN AUSTRALIA

by

D.J. FORMAN & W.J. McAVOY

IN-CONFIDENCE

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ABSTRACT

The hydrocarbon potential of the Tithonian play in the Dampier Sub-basin has been rapidly assessed as part of a continuing program of quantitative appraisal of Australia's hydrocarbon potential. Six wells have already tested the play; of these Angel was a significant gas discovery and Egret was a significant oil discovery. The remaining potential in four undrilled prospects (Courtenay, Wallcot, Nickol, and Finucane) has been assessed by the prospect by prospect method, using a Monte Carlo simulation computer program called SIMULAT.

If all four prospects are drilled there is a 70 percent chance of finding some gas and a 50 percent chance of finding some oil. Addition of the hypothetical resources yields a risked mean estimate for the four propsects of 21 x $10^6 m^3$ of recoverable oil and 38 x $10^9 m^3$ of recoverable gas.

INTRODUCTION

The recoverable hydrocarbon potential of the Tithonian play in the Dampier Sub-basin has been assessed as part of a continuing program of quantitative appraisal of the hydrocarbon potential of Australia. All relevant information available to BMR (from BOCAL) has been used to arrive at the conclusions presented in this report. The geology has been summarised by Powell (1976) and the environments of deposition of the Tithonian sediments are summarised in BOCAL (1976a).

Identified resources

Demonstrated

The Angel gas and condensate field and the Egret oil field contain demonstrated resources. The most recent estimates (BOCAL, 1977) are tabulated below.

DEMONSTRATED RESOURCES (m^3)

31 March 1977

	Augel		Egret	
	in place	recoverable	in place	recoverable
natural gas	77.6×10^9	40.4×10^9		
sales gas		36×10^9		
condensate	23.9×10^6	9.5×10^6		
LPG		8.25×10^6		
crude oil			4.3×10^6	1×10^6

PLAY ASSESSMENT

Play definition

Fold, fault, and stratigraphic traps containing Tithonian (Upper Jurassic) reservoir sandstones sealed by Tithonian or Cretaceous claystone and sourced by Upper Jurassic or Cretaceous claystone.

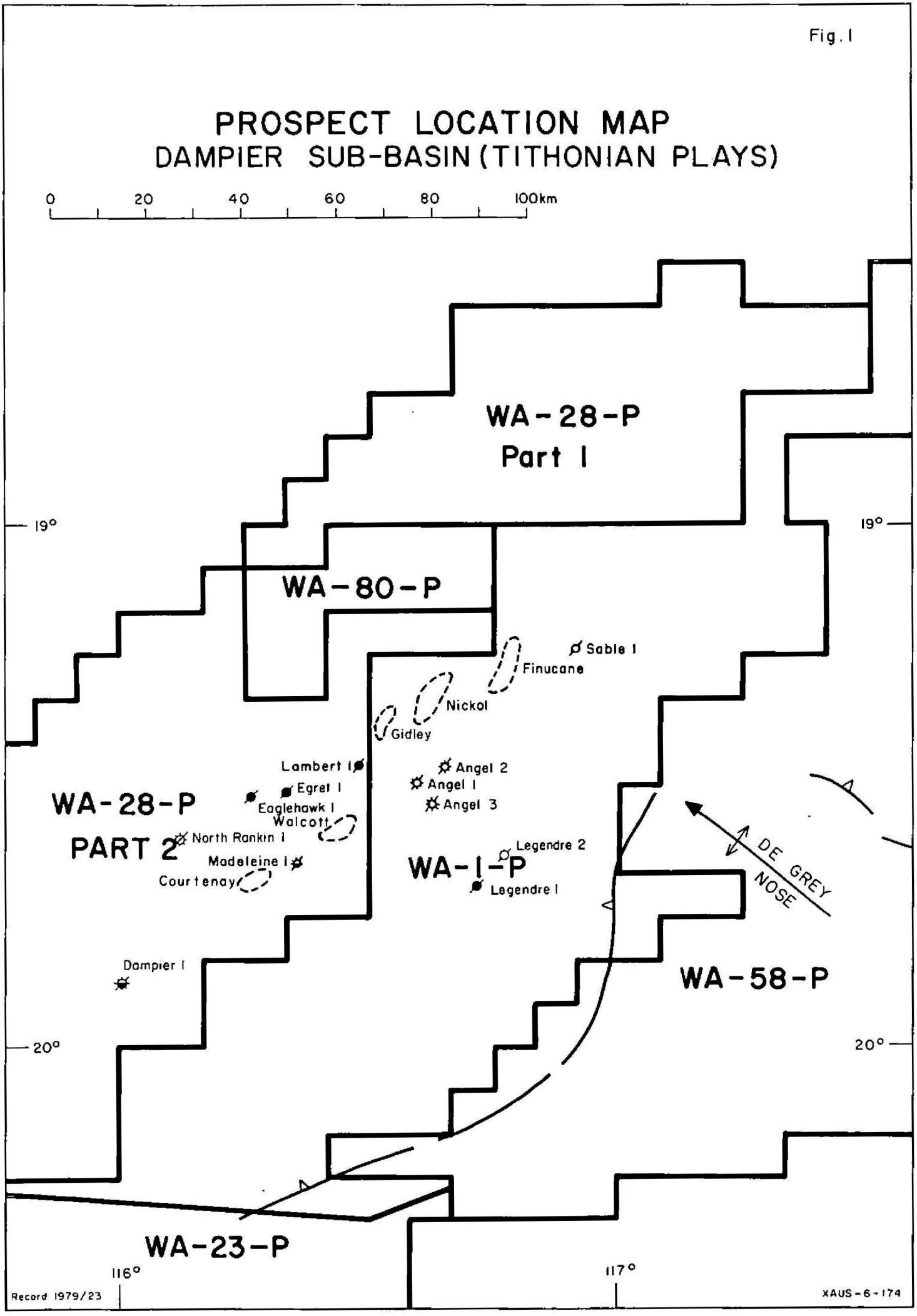
Prospects (Fig. 1)

(1) The Courtenay structure appears on the main unconformity and top Tithonian horizon maps as a faulted closure against a major fault with a downthrow to the southeast. It is located about 16 km south of North Rankin No. 1 and 15 km west of Madeleine No. 1.

(2) The Walcott structure appears on the main unconformity and top Tithonian horizon maps as a high closed against a major fault with a downthrow to the southeast. It is located 10 km northeast of Madeleine No. 1.

Fig. 1

PROSPECT LOCATION MAP
DAMPIER SUB-BASIN (TITHONIAN PLAYS)



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(3) The Finucane structure is shown as a north-northeast-trending horst block on the main unconformity and the top Tithonian horizon maps. It is situated 15 km west of Sable No. 1.

(4) The Nickol structure is a fault trap visible on the main unconformity and the top Tithonian horizon maps. Vertical closure exists only if the fault forms a seal. It is located about 30 km southwest of Sable No. 1.

(5) The Gidley structure appears on the main unconformity and top Tithonian horizon maps as a poorly developed fault block. It is located about 8 km northeast of Lambert No. 1. Because of the small areal and vertical closures associated with Gidley, no estimate of resources has been made.

Generation

The following tests of the play discovered recoverable hydrocarbons: Angel Nos. 1-3 (gas) and Egret No. 1 (oil).

Minor hydrocarbon shows were reported at several levels from the play in Madeleine No. 1 and another promising zone could not be tested. The failure to produce significant quantities of hydrocarbons from this well is tentatively attributed to a position off-structure from a hypothetical accumulation in the Walcott structure. Dampier No. 1 discovered a high-pressure low-volume hydrocarbon accumulation (gas?) in a Tithonian formation with no permeability. Legendre No. 1 discovered oil in lower Neocomian to Tithonian? sandstones which were missing in Legendre No. 2. Tithonian sandstones in Legendre No. 2 were found to be 100-percent water-bearing.

These discoveries prove that both oil and gas have been generated. All the oil occurrences are of a paraffinic oil sourced from Upper Jurassic and Lower Cretaceous beds in the Dampier Sub-basin.

The threshhold temperature for commercial generation of the paraffinic oils was estimated by BOCAL (Woodside, 1976) to be about 130°C, or at spore maturation index 8.

Time of migration

No study of the time of migration has been made. The three prospects on the Rankin Trend (Finucane, Nickol, and Gidley) probably developed at about the same time as the oil-bearing structures Eaglehawk, Egret, and Lambert, and therefore the timing with respect to maturation is probably favourable. The two best prospects, Walcott and Courtenay, on the flanks of the Rankin Trend in the Kendrew Terrace, like Angel, are assumed to have a favourable sequence of trap development with respect to maturation.

Reservoir

Reservoir-quality sandstone is present within the Tithonian sequence penetrated at Lambert No. 1, Egret No. 1, Angel Nos. 1-3, and Madeleine No. 1. The sands disappear by shaling out towards Dampier No. 1. The Tithonian sequence is absent in uplifted areas of the Rankin Trend such as at Eaglehawk No. 1, the North Rankin wells, and Sable No. 1.

RESERVOIR PARAMETERS

Estimated reservoir parameters are listed in Table 1.

Trap volume

A range of values for trap volume was estimated using the area versus depth-of-contour method on the 1:100 000-scale time maps of the top Tithonian horizon (BOCAL, 1976b).

Percent net pay

A range of values for percent net pay was estimated for the Walcott and Courtenay prospects using Map 9 (BOCAL, 1976b) and data from wells drilled in the vicinity; Egret No. 1 (BOCAL, 1972), Lambert No. 1 (BOCAL, 1973), Angel No. 1 (BOCAL, 1971), and Madeleine No. 1 (BOCAL, 1969). The range of values for Finucane and Nickol is based on correlation and extrapolation of lithologies between Lambert No. 1 and

Sable No. 1 and seismic data. A study of record sections 76-1581 and 76-1582 from the Tessa-Troubadour marine survey (BOCAL, 1976b) suggest a facies change from shale to sand west of Sable No. 1, indicating that there are improved prospects of good Tithonian reservoirs at the Finucane and Nickol locations.

Percent trap fill

A range of values for percent trap fill was estimated from general considerations of source potential and thermal history, and by comparison with trap fill in the Egret and Angel accumulations.

Demaison (1974) concluded that the Upper Jurassic and Neocomian delta-front shales of the Barrow-Dampier Sub-basin are generally organic rich, and show excellent potential for generation of mainly wet gas and subordinate light paraffinic oil. Demaison's Degree of Organic Maturity Map of the top of the Upper Jurassic shows the maturity in the area adjacent to the Courtenay and Walcott prospects as suitable mainly for wet gas, and the maturity near to the Finucane and Nickol prospects as suitable for wet gas and oil.

The established presence of hydrocarbons in other wells situated near the margin of the Lewis Trough of the Dampier Sub-basin indicates that adequate migration paths are available.

Porosity of reservoir

The range of porosity values selected was based on actual porosity determinations in the nearest wells. Porosity is expected to improve at the Nickol and Finucane prospects which are closer to the expected source of sediments, the de Grey Nose.

Water saturation

The range of values of water saturation selected was based on actual water saturations in adjacent fields.

Pressure, temperature, gas deviation factor, and formation volume factor

Single-value estimates were made of the gas deviation factor, formation volume factor, reservoir temperature (T), and reservoir pressure (P).

Reservoir temperature was obtained by interpolation from temperature maps (BOCAL, 1975). Reservoir pressure was estimated using the formula $P = 15 + 0.44 \times$ depth in feet.

Recovery factor

Gas-recovery factors were calculated from pressure data, on the assumption of an abandonment reservoir pressure of 1000 psi. Primary oil-recovery factors were estimated from figures for existing fields (BOCAL, 1974).

EXISTENCE RISK

The risks for each critical factor are summarised in Table 2. These risks have been used to calculate the existence risks for each prospect and for the remaining play potential.

RESULTS

The hypothetical unrisked recoverable resources of each prospect have been estimated using program SIMULAT (Riesz, 1978), and the results are compared in Figures 2 and 3. The hypothetical resources of the prospects have also been added using program SIMULAT, and the results are plotted in Figures 4 and 5. Mean estimates, risked and unrisked, are summarised below.

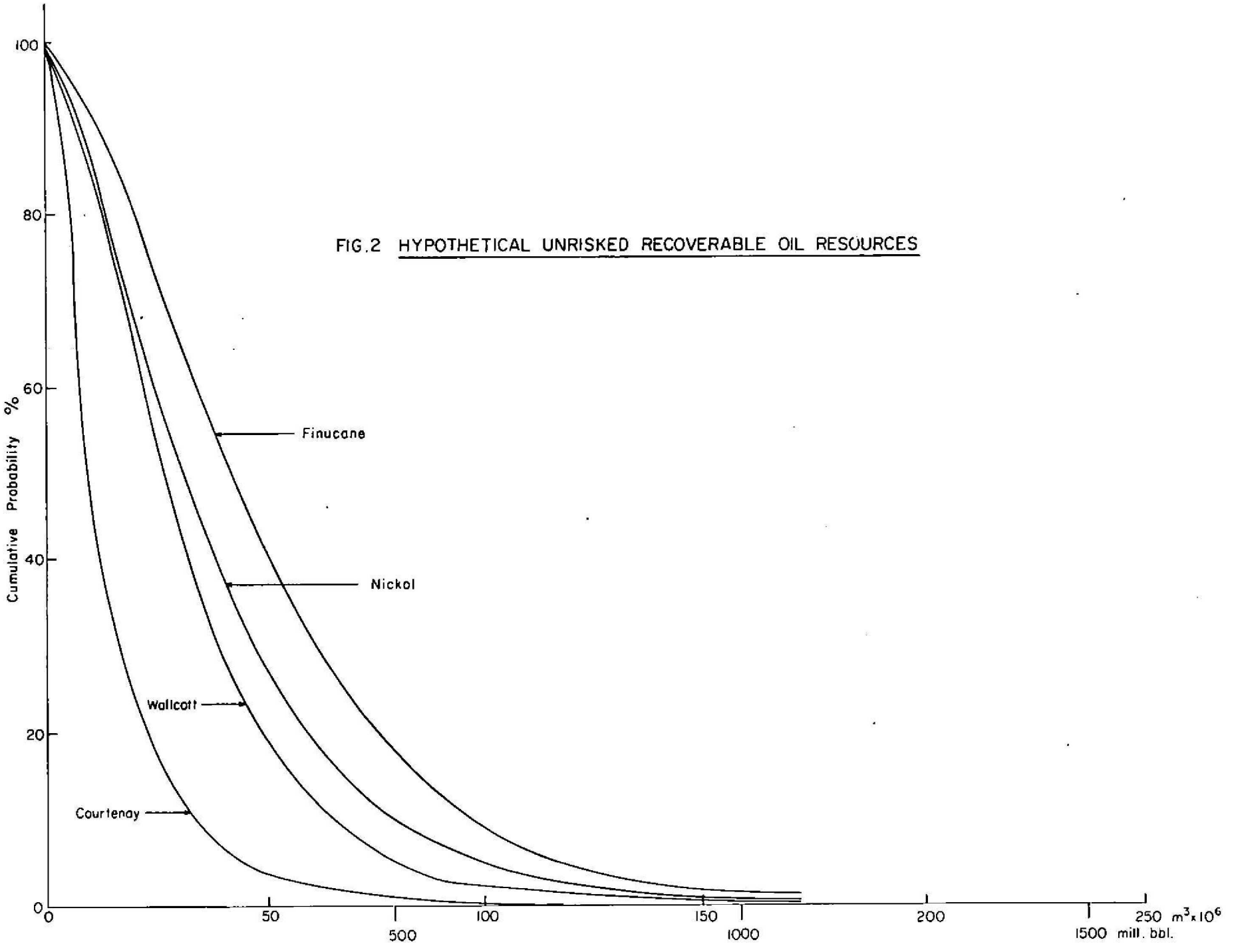

FIG.2 HYPOTHETICAL UNRISKED RECOVERABLE OIL RESOURCES

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FIG. 3 HYPOTHETICAL UNRISKED RECOVERABLE GAS RESOURCES

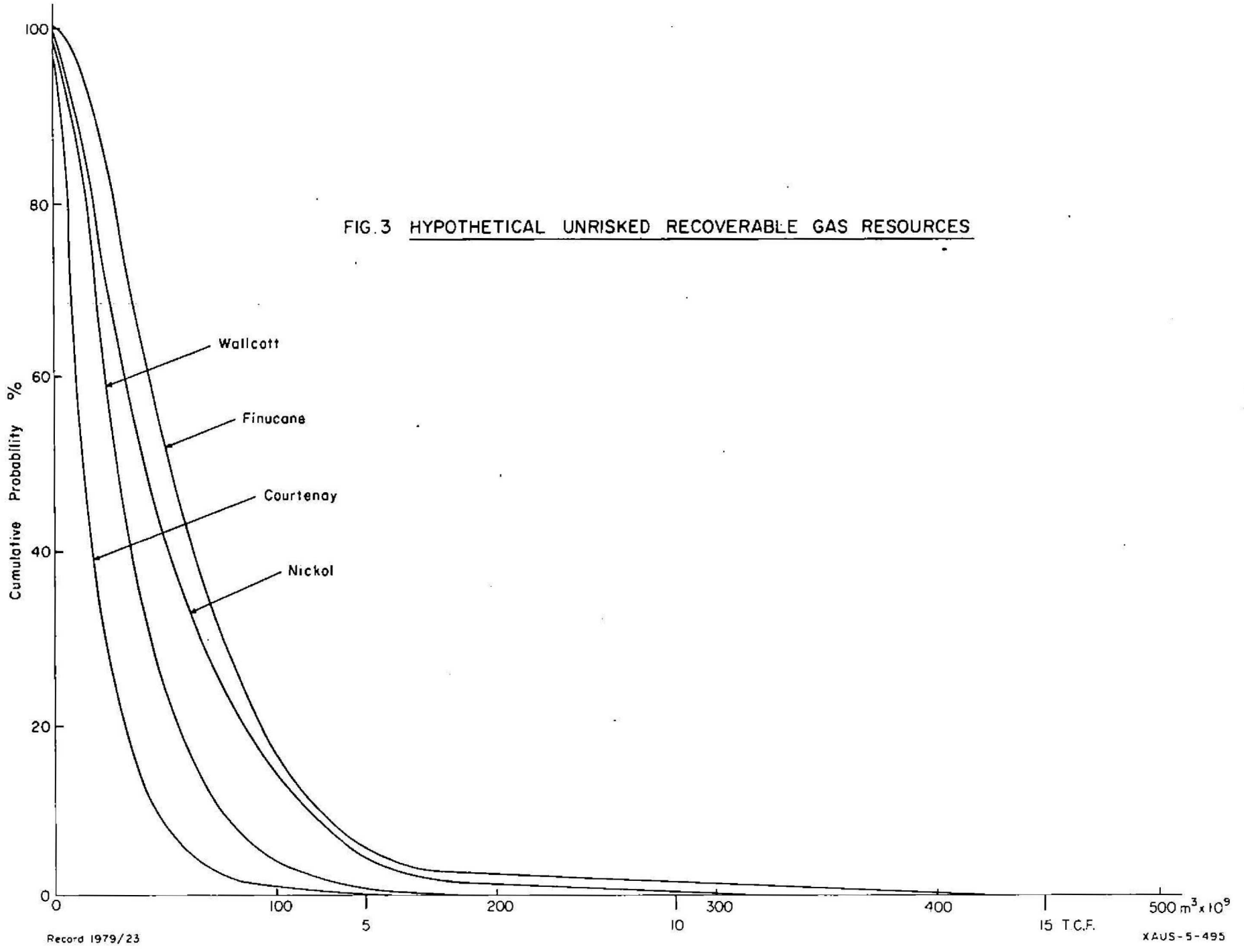

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FIG. 4 HYPOTHETICAL RISKED RECOVERABLE OIL RESOURCES

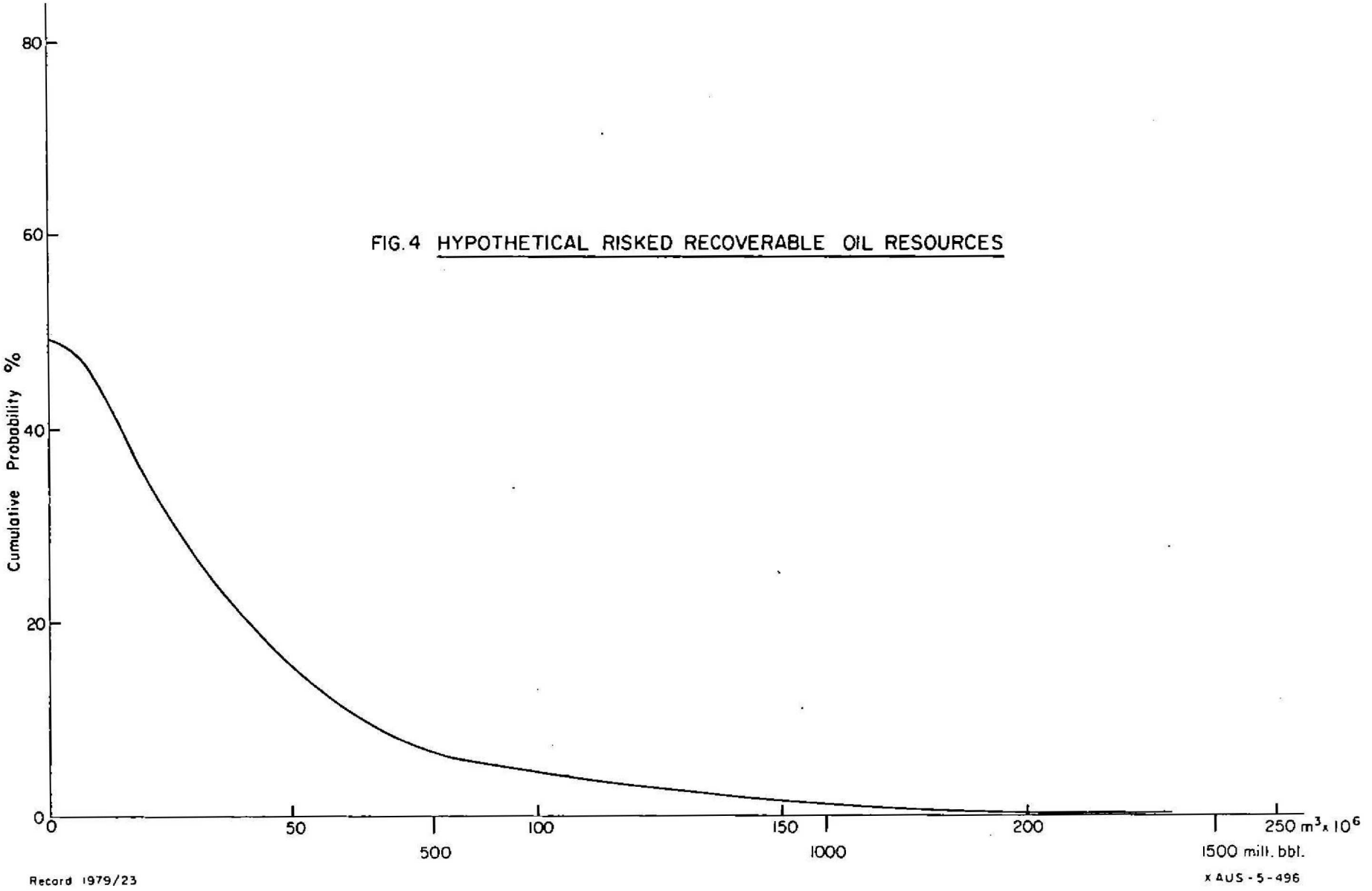

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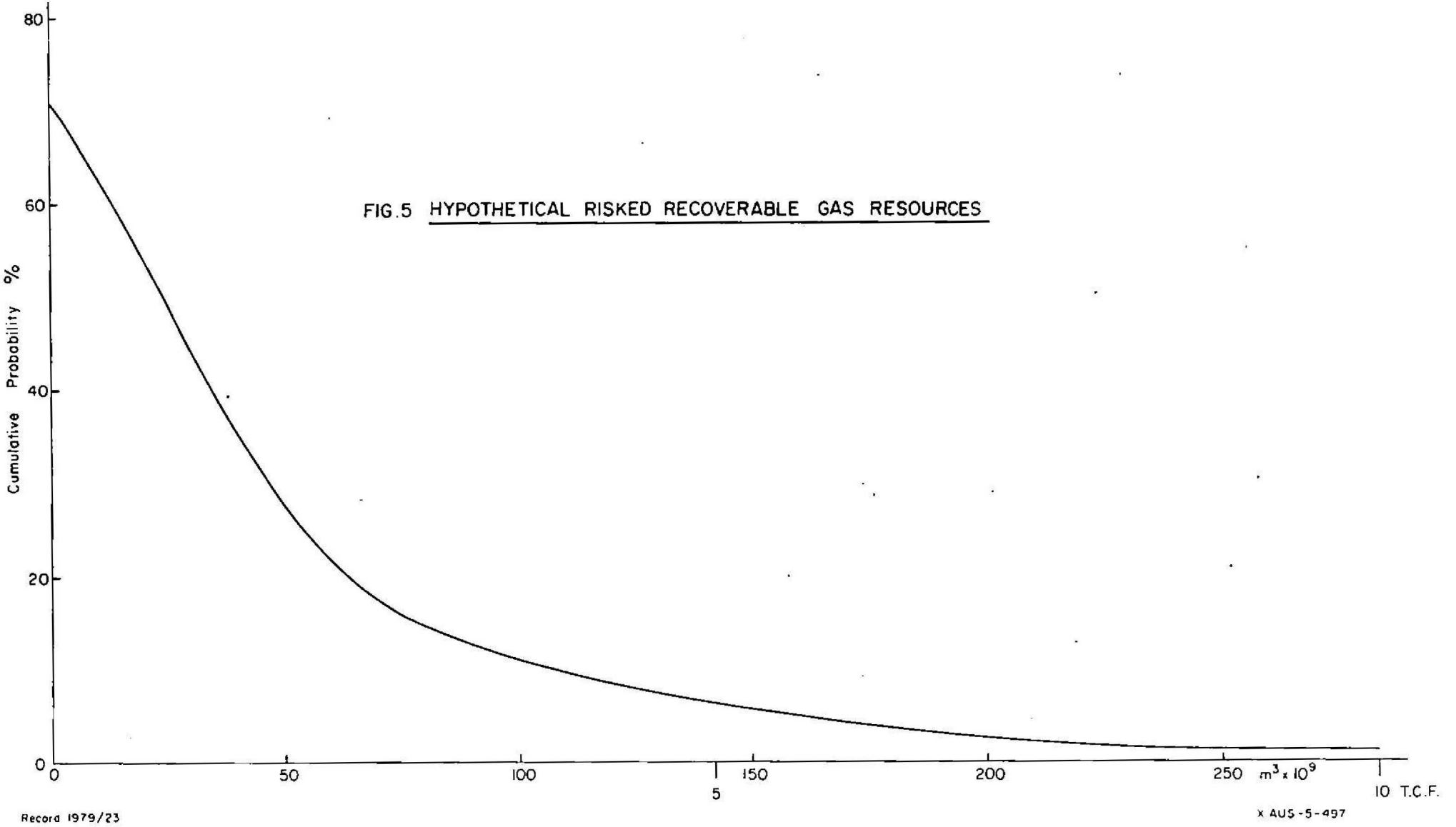
FIG.5 HYPOTHETICAL RISKED RECOVERABLE GAS RESOURCES



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Recoverable hypothetical resources (m^3)

	mean estimate (unrisked)		existence risk		risked mean	
	oilx10^6	gasx10^9	oil	gas	oilx10^6	gasx10^9
Wallcott	34	38	0.25	o.5	8	18
Courtenay	15	20	0.13	0.27	2.0	5.6
Finucane	51	63	0.13	0.13	6	7.9
Nickol	40	53	0.13	0.13	5	6.7
All prospects combined			0.50	0.70	21	38

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RESERVOIR PARAMETERS

Table 1

Trap	Trap Volume				Net Pay		Trap Fill		ϕ		S_w		Recovery Factor				Reservoir					Z Gas Dev. Fract		Formation Volume Factor	
	contours used	area km^2	volume $m^3 \times 10^6$	weight	m	weight	fract	weight	fract	weight	fract	weight	oil	weight	gas	weight	depth m	T °R	weight	P psig	weight		weight		weight
Courtenay	2·050	34·7	277·6	0	5	0	15	0	10	0	10	0													
	2·065	46·5	3063·2	1	15	1	50	1	15	1	25	1	25	1	78	1	3109	691	1	4503	1	0·92	1	1·70	1
	2·080	54·5	9221·2	0	100	0	100	0	23	0	42	0													
Walcott	1·850	50·3	2313·8	0	10	0	15	0	17	0	10	0													
	1·875	62·2	5750·1	1	25	1	50	1	20	1	25	1	25	1	75	1	2743	673	1	3975	1	0·92	1	1·70	1
	1·900	73·4	11635·74	0	100	0	100	0	23	0	42	0													
Finucane	2·20	28·2	1601 6	0	15	0	15	0	15	0	10	0													
	2·25	51·5	6946·8	1	40	1	50	1	25	1	25	1	25	1	77	1	3005	677	1	4353	1	0·92	1	1·70	1
	2·28	122·9	13382	0	100	0	100	0	30	0	42	0													
Nickol	2250	13·0	318·5	0	15	0	15	0	15	0	10	0													
	2300	59 5	3834	1	40	1	50	1	25	1	25	1	25	1	80	1	3383	694	1	4899	1	0·92	1	1·70	1
	2360	95·7	13323	0	100	0	100	0	30	0	42	0													

EXISTENCE RISK PARAMETERS

Table 2

Trap	Source		Thermal History		Reservoir		Trap and Seal		Timing		Flushing		Oil vs Gas	
	risk	weight	risk	weight	risk	weight	risk	weight	risk	weight	risk	weight	oil	gas
Courtenay	1		1		0·5		0·9		0·9		1		1	2
Walcott	1		0·9		0·9		0·9		0·9		1		1	2
Finucane	1		1		0·5		1		0·5		1		1	1
Nickol	1		1		0·5		1		0·5		1		1	1