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A CORRELATION OF THE TERTIARY OF A.O.G. WENTWORTH NO.1, WOODSIDE OIL BALRANALD NO.1 AND WOODSIDE OIL BUNDY NO.1 WELLS, MURRAY BASIN

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by

P.R. Evans and E.A. Hodgson

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CONTENTS

		Page
SUMMARY		1
INTRODUCTION		1
OBSERVATIONS		1
DISCUSSION		4
CONCLUSIONS		5
ADDENDUM	COMMENTS ON A.O.G. JERILDERIE NO.1 WELL.	5
REFERENCES		6
APPENDIX I	LOCATION, ELEVATION AND DEPTH OF WELLS.	7
APPENDIX II	DEPTHS SAMPLED IN O.D.N.L. MOUNT SALT NO.1 WELL.	8
TABLE I	DISTRIBUTION AND PERCENTAGE ABUNDANCE OF SPECIES OF NOTHOFAGUS RELATIVE TO TOTAL ACID-INSOLUBLE MICROFOSSIL CONTENT.	2
TABLE II	DISTRIBUTION AND PERCENTAGE ABUNDANCE OF POLLEN AND MICROPLANKTON.	3
PLATE 1	SKETCH MAP OF PART OF MURRAY BASIN SHOWING LOCATION OF WENTWORTH NO.1, BALRANALD NO.1 AND BUNDY NO.1.	
PLATE 2	DISTRIBUTION AND RELATIVE ABUNDANCES OF SELECTED TERTIARY POLLENS IN A.O.G. WENTWORTH NO.1, WOODSIDE OIL BALRANALD NO.1 AND BUNDY NO.1 WELLS.	
PLATE 3	TENTATIVE CORRELATION OF THE TERTIARY OF WENTWORTH NO.1, BALRANALD NO.1 AND BUNDY NO.1 BASED ON THE RATIO OF NOTHOFAGUS TO TRIORITES HARRISII	

A CORRELATION OF THE TERTIARY OF A.O.G. WENTWORTH NO.1, WOODSIDE OIL BALRANALD NO.1 AND WOODSIDE OIL BUNDY NO.1 WELLS, MURRAY BASIN

SUMMARY

Samples from the Tertiary sections of Wentworth No.1, Balranald No.1 and Bundy No.1 Wells in the Murray Basin contain similar types of acid insoluble microfossils, although the great abundance of microplankton at certain depths in Wentworth No.1 has no equal in either of the other wells. Variations with depth of the abundance of certain species of Nothofagus are demonstrated. Taken into consideration with the distribution of other pollens, in particular Triorites harrisii, they are a means of correlating the well sections. The ratio of Nothofagus to Triorites harrisii shows marked variations with depth and behaves similarly in all three wells. On the basis of these variations it is suggested that correlates of the Glenelg Group and Knight Group of Wentworth No.1 are present in both Balranald No.1 and Bundy No.1. Facies variations from marine to freshwater conditions in an easterly direction in the basin are indicated.

INTRODUCTION

Fossiliferous samples taken at intervals of about 300 feet from Balranald No.1 were studied to observe variations in the distribution in the Tertiary of species of Nothofagus in terms of the observations by Cookson (1946, 1947, 1950, 1953, 1954) and Cookson and Pike (1953, 1954). It was noticed that gross complementary variations in the abundance of the genus Nothofagus and the species Triorites harrisii occurred with depth. In consequence, material from Bundy No.1 and from Wentworth No.1 was examined to test the possibility of using such variations as stratigraphic markers. Bundy No.1 (Shiels, 1962), Balranald No.1 (Benbow, 1962) and Wentworth No.1 (Rose, 1962)* form an east-west section across the centre of the Murray Basin (Plate 1). When possible samples were taken at 300 feet intervals from each well and pollen counts were made on each sample using at least 150 specimens. The work of de Jekhowsky (1958) on the stratigraphic use of microfossils served as a guide to these investigations.

The Tertiary section in the Otway Basin, mostly below the Gambier Limestone, of Mount Salt No.1 (295 miles south of Wentworth) was similarly examined in an attempt to obtain an understanding of the distribution and abundances of the chosen forms in the thicker and apparently older developments of the Knight Group of the Gambier Sunklands.

At present no data are available from sections younger than that of Wentworth No.1.

OBSERVATIONS

The abundance and distribution of species of Nothofagus in the three wells are shown in Table I while similar data for the genus Nothofagus and all other microfossils are presented in Table II. The vertical distribution of the more important forms and variations in the ratio of Nothofagus to T.harrisii are shown graphically in Plate 2.

No microplankton are recorded from Bundy No.1 Well and they were extremely rare in Balranald No.1. In Wentworth No.1, where microplankton are abundant, the relative percentages of the major pollen groups have been recalculated in terms of the spore content only.

* Locations of these wells are given in Appendix I.

TABLE I

		Nothofagus emarcida	Nothofagus hetera	Nothofagus cincta	Undifferentiated Nothofagus
WENTWORTH No.1 Well					
Cuttings	317 - 327 feet	15	12	-	-
Cuttings	495 - 504 feet	8	5	-	-
Cuttings	735 - 742 feet	4	2	-	-
Cuttings	940 - 951 feet	28	23	1	-
Cuttings	1127 - 1137 feet	15	28	2	-
BALRANALD No.1 Well					
Cuttings	300 - 310 feet	12	7	3	1
Core 1	611 - 613 feet	10	12	1	2
Core 2	930 - 950 feet	17	35	7	3
Cuttings	980 - 990 feet	12	30	5	5
BUNDY No.1 Well					
Core 3	680 - 700 feet	10	56	3	-
Core 4	920 - 922 feet	7	23	3	-
Core 5	1264 - 1266 feet	4	16	1	-

Distribution and percentage abundance of species of Nothofagus relative to total acid-insoluble microfossil content.

TABLE II

		Nothofagus (all species)	Triorites harrisii	Inaperturopollenites spp.	Undifferentiated monocolpate pollen	Podocarpaceous pollen	Proteacidites granulatus	Araucariacites spp.	Dacrydium sp	Dacrydiumites spp.	Myrtaceidites mesonesus	Ischyosporites spp.	Gleichenia spp.	Casuarinidites cainozoicus	Cyatheidites spp.	Monosaccate pollen	Microplankton
WENTWORTH No.1 Well																	
Cuttings	317- 327 feet	27	7	38	5	4	-	5	-	-	3	-	2	2	6	-	1
Cuttings	495- 504 feet	13	14	32	6	8	-	8	1	-	4	-	3	2	3	-	6
	*	14	15	34													
Cuttings	735- 742 feet	6	9	13	3	3	-	-	3	-	-	-	1	-	2	-	60
	*	15	22	33													
Cuttings	940- 951 feet	52	9	9	2	3	1	7	2	5	4	-	2	1	3	-	-
Cuttings	1127-1137 feet	45	12	5	9	5	1	10	2	7	1	-	1	-	2	-	-
BALRANALD No.1 Well																	
Cuttings	300- 310 feet	23	21	-	9	4	1	-	13	6	13	-	2	7	-	1	-
Core 1	611- 613 feet	25	9	-	14	4	2	6	-	3	30	-	-	-	-	6	1
Core 2	930- 950 feet	62	5	-	5	7	1	-	-	4	4	-	-	-	-	9	3
Cuttings	980- 990 feet	52	13	-	6	5	1	4	2	-	11	1	-	3	1	-	1
Cuttings	1000-1010 feet	barren															
Cuttings	1080-1090 feet	barren															
BUNDY No.1 Well																	
Cuttings	200 feet	barren															
Core 1	305- 307 feet	barren															
Cuttings	500 feet	barren															
Core 3	680- 700 feet	69	18	2	7	2	2	-	-	-	-	-	-	-	-	-	-
Core 4	920- 922 feet	33	15	10	4	10	-	-	4	2	-	22	-	-	-	-	-
Core 5	1264-1266 feet	21	19	7	11	10	11	3	4	8	1	5	-	-	-	-	-

* percentages corrected to exclude microplankton.

Distribution and percentage abundance of pollen and microplankton.

Ten cores from the Tertiary section of Oil Development Mount Salt No.1 were examined but because of poor yields, counts of the pollen grains within them can have no stratigraphical significance. (Depths sampled are listed in Appendix II.)

DISCUSSION

The Tertiary of Wentworth No.1 provides the most likely reference section to the stratigraphic column at present available. It is therefore used here as the starting point for discussion. The formation names used below are those employed by Ludbrook (1962), and the group names are derived from Glaessner (1958). It is emphasized that these names are used only to facilitate discussion and to provide a guide to which parts of the Tertiary section are under consideration. They provide a convenient means of sub-dividing the Wentworth section without resorting to divisions in terms of depth in the bore alone. The intervals of uncertainty between sampled points make any correlation of quantitatively defined units have little meaning. On the other hand, to consider for example a possible correlate of the "upper part of the Knight Group of Wentworth No.1" is sufficient to express the indications justified by the present analysis.

Nothofagus is very common in the Knight Group of Wentworth No.1, and increases in abundance (from 45% to 52%) towards the top of the unit while Triorites harrisii decreases slightly (from 12% to 9% nearer the top). The corresponding ratio of Nothofagus to T. harrisii is as high as 6:1 in the top part of the Knight Group but towards the top of the Glenelg Group i.e. where microplankton are common, it falls to approximately 1:1.5. A comparable ratio (1:1) is maintained near the top of the Morgan Formation where the microflora contains 14% Nothofagus and 15% T. harrisii. In the middle of the Bookpurnong Beds Nothofagus increases to 27% while T. harrisii drops to 7%, the corresponding ratio being approximately 4:1. Inaperturopollenites spp. show a steady increase from 5% in the Knight Group to 38% in the Bookpurnong Beds.

At Balranald, although microplankton and some pollen are less abundant than in Wentworth No.1, the behaviour of Nothofagus and Triorites harrisii is similar to that in Wentworth No.1, both in the complementary nature of their variations and in the actual pattern of change of abundance of each form with depth. The microfloral contents of samples from 980 - 990 feet, 930 - 950 feet (Core 2) and 611 - 613 feet (Core 1) define a maximum in the Nothofagus/T. harrisii ratio which compares with a similar peak near the top of the Knight Group section of Wentworth No.1 Well. The maximum in Balranald No.1, at 930 - 950 feet, is characterized by a Nothofagus content of 62% and a T. harrisii content of only 5% giving a ratio of the two of 12:1. The comparable maximum at Wentworth is 6:1. The change in ratio between 613 feet and 300 feet in Balranald No.1 is similar to that in the Glenelg Group and lower Murray Group of Wentworth No.1: at 611 - 613 feet Nothofagus comprises 25% of the microflora and T. harrisii 9%; at 300 - 310 feet they are 23% and 21% respectively. In consequence, it is suggested that the Balranald section between 300 feet and 990 feet correlates with the uppermost Knight Group, the Glenelg Group and possibly a lower part of the Murray Group at Wentworth.

The fossiliferous samples from Bundy No.1 Well, Cores 5 (1264 - 1266 feet), 4 (920 - 922 feet) and 3 (680 - 700 feet), contain 21%, 33% and 69% Nothofagus respectively. The percentage of T. harrisii in all three samples is between 15% and 19%. Because samples from 500 feet and 200 feet were barren it is not possible to gauge the upper limit of the abundance of Nothofagus. Because the fossiliferous section of Bundy No.1 is associated with a Nothofagus/T. harrisii ratio that decreases with depth, it may be correlated with either the upper Knight and Glenelg Groups or with the Murray Group of Wentworth No.1. The older samples in Wentworth No.1 and Balranald No.1 show a marked increase of Nothofagus hetera relative to Nothofagus omarcida (Table I). As the fossiliferous section of Bundy No.1 shows a similar relative abundance of Nothofagus hetera it is suggested that the Bundy section below 700 feet should be compared with the Knight Group, rather than with the Glenelg or Murray Groups of Wentworth.

The spacing between sampling points in this exercise was such that, assuming the curve is unimodal, the actual maximum of the Nothofagus/T. harrisii ratio is unlikely to occur exactly where the graphs of Plates 2 and 3 imply. However we are left with sections of opposing slopes either side of this maximum which are the main indicators of correlation. With these in mind when the correlation is superimposed on the lithological sequences certain lateral changes in facies are apparent.

Commencing at the base of the section, the Nothofagus/T. harrisii ratio is increasing. It does so through a section of sandstone and sandy siltstone at Wentworth (the Knight Group). At Balranald the increase is related to dolomitic sandstone and carbonaceous mudstone. At Bundy it is related to an apparently much thicker section than in either of the other wells, a section through siltstone, sandstone, silty sandstone and lignite. With the exception of the carbonaceous mudstones at Balranald this increase is thus associated with a mainly arenaceous suite of (?)non-marine rocks. Even the carbonaceous mudstones at Balranald might be linked with the lignite development at Bundy.

The zone of decrease in the Nothofagus/T. harrisii ratio on the other hand is apparently associated with very varied environments of deposition across the basin. At Wentworth it includes the marine facies of marls and limestone (Glenelg Group). At Balranald, however it includes sandstones, glauconitic mudstones and a development of dolomite, none of which yielded marine microfossils as abundantly as its correlate at Wentworth. The lack of data from Bundy demonstrating the decrease in ratio makes correlation that far to the east impossible. However, as this zone shows signs of being lignitic at Balranald it is tempting to speculate that it is represented by the more lignitic section of Bundy No.1 between about 400 and 650 feet. If this is correct then a case of progressive facies change from open sea conditions in the west to freshwater paludal conditions in the east is demonstrated. (See Addendum).

CONCLUSIONS

Species of Nothofagus have different distributions and abundances at various depths in the Tertiary of Wentworth No.1, Balranald No.1 and Bundy No.1. Although such variations may be of some correlative use, it is suggested that observations of variations with depth in abundance of the genus Nothofagus and of the species Triorites harrisii might be helpful in the stratigraphic interpretation of the Tertiary of the Murray Basin. On the basis of these variations it is suggested that part of the Balranald No.1 section correlates with the upper Knight Group, Glenelg Group and Murray Group of Wentworth No.1. The fossiliferous section of Bundy No.1 may be older and may correlate with the upper Knight Group and Glenelg Group of Wentworth No.1.

The number of samples on which these conclusions have been based is not sufficient for precise correlation. Additional information from more closely sampled intervals is needed in any future work.

ADDENDUM

COMMENTS ON A.O.G. JERILDERIE No.1 WELL

As results from this well were not available until after the work for the present paper had been almost completed it was not possible to include Jerilderie No.1 in the investigation. Cores 2 (619 - 629 feet) and 6 (875 - 891 feet) from Jerilderie were examined and found to contain abundant pollens (Nothofagus spp. were common in both samples). The following pollens were present in Core 6.

Nothofagus emarcida	30%	Dacrydiumites spp.	
N. hetera	20%	Podocarpidites spp.	
N. aspera		Triorites edwardsii	
N. falcata		T. harrisii	5%

The relative proportions of N. emarcida, N. hetera and T. harrisii and the presence of T. edwardsii indicate a probable correlation between this horizon (Core 6) of Jerilderie No.1 with one near the top of the Knight Group of Wentworth No.1.

If this correlation is correct, the sequence of lithological units above Core 6 fits into the pattern of west-east facies variations suggested in the discussion above. The Jerilderie correlate of the upper Knight Group of Wentworth No.1 is arenaceous and it underlies lignitic sediments. At Bundy the probable correlates of these lignitic sediments are also lignitic. Time equivalents of the Bundy lignitic sediments include sandstones, glauconitic mudstones and dolomite at Balranald and the marine facies of marls and limestones at Wentworth.

REFERENCES

BAKER, G., and COOKSON, I.C., 1955 - Age of the Nelson bore sediments. Aust.J.Sci. 17(4), 133-134.

BENBOW, D.D., 1962 - Well Completion Report, Woodside (Lakes Entrance) Oil Co. N.L., Balranald No.1 Well (unpubl.).

COOKSON, I.C., 1946 - Pollens of Nothofagus Blume from Tertiary deposits in Australia. Proc.Linn.Soc. N.S.W. 71(2), 49-63.

COOKSON, I.C., 1953 - Difference in microspore composition of some samples from a bore at Comaum, South Australia. Aust.J.Bot. 1(2), 462-473.

COOKSON, I.C., 1954 - A palynological examination of No.1 bore, Birregurra, Victoria. Proc.Roy.Soc.Vic. 66, 119-128.

COOKSON, I.C., 1959 - Fossil pollen grains of Nothofagus from Australia. Proc.Roy.Soc.Vic. 71(1), 25-30.

COOKSON, I.C., and PIKE, K., 1953 - A contribution to the Tertiary occurrence of the genus Dacrydium in the Australian region. Aust.J.Bot. 1(3), 472-484.

COOKSON, I.C., and PIKE, K., 1954 - Some dicotyledenous pollen types from Cainozoic deposits in the Australian region. Aust.J.Bot. 2(2), 197-219.

de JEKHOWSKY, B., 1958 - Methodes d'utilisation stratigraphique des microfossiles organiques dans les problemes petroliers. Rev.Inst.Fr.Petrole.et.Ann.Comb.Liq. 8(10), 1391-1418.

GLAESSNER, M.F., (ed.) 1958 - The Geology of South Australia. J.Geol.Soc.Aust. 5(2), 1-163.

LUDBROOK, N.H., 1960 - Stratigraphy of the Murray Basin in South Australia. Geol.Surv.S.Aust.Bull. 36.

LUDBROOK, N.H., 1962 - Report on Wentworth No.1 bore, subsurface stratigraphy and micropalaeontological study by Dr. N.H. Ludbrook. Appendix in Australian Oil and Gas Corporation Limited Well Completion Report, Wentworth No.1 Bore, New South Wales (unpubl.).

ROSE, D., 1962 - Australian Oil and Gas Corporation Limited Well Completion Report, Wentworth No.1 Bore, New South Wales (unpubl.).

SHIELS, O.J., 1962 - Well Completion Report, Woodside (Lakes Entrance) Oil Co. N.L., Bundy No.1 Well (unpubl.).

APPENDIX I

LOCATION, ELEVATION AND DEPTH OF WELLS

Australian Oil and Gas Corporation Wentworth No.1 Well

Latitude 33°48' S, Longitude 141°58' E.

County Wentworth, New South Wales.

Ground elevation 130 feet above sea level.

Total depth 2,081 feet.

Woodside (Lakes Entrance) Oil and Planet Oil Balranald No.1 Well

Latitude 34°39'20" S, Longitude 143°29'32" E.

Riverina district, New South Wales.

Ground elevation 214 feet above sea level.

Total depth 1,321 feet.

Woodside (Lakes Entrance) Oil and Planet Oil Bundy No.1 Well

Latitude 35°03'00" S, Longitude 144°31'18" E.

Riverina district, New South Wales.

Ground elevation 262 feet above sea level.

Total depth 1,376 feet.

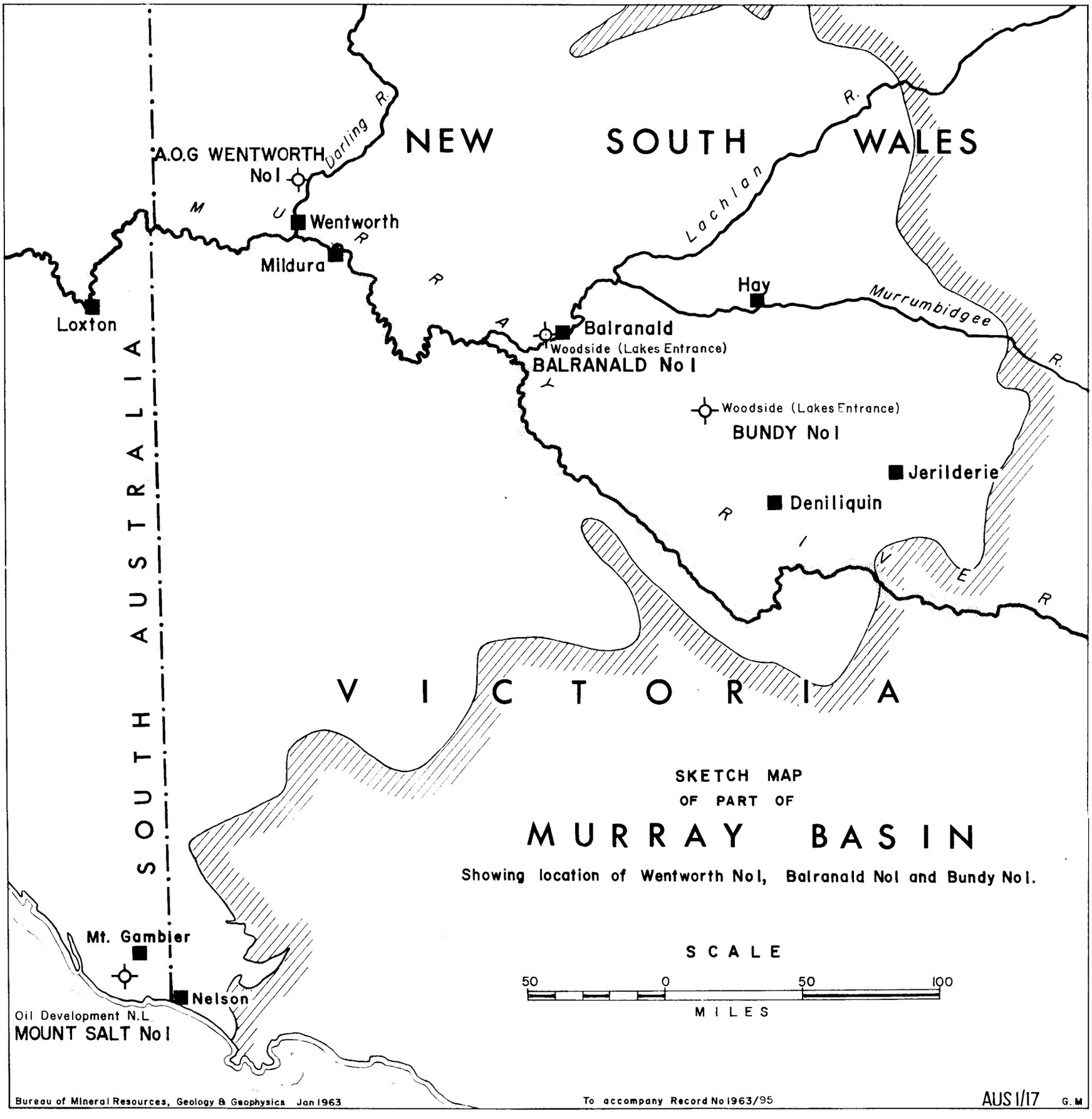
APPENDIX II

DEPTHS SAMPLED IN O.D.N.L. MOUNT SALT No.1 WELL

The following cores from the Tertiary part of the well were examined but, because of poor yields, no material from Mount Salt No.1 was used for pollen grain counts.

Core 1	(996 feet)
Core 3	(1605 feet)
Core 4	(1921 feet)
Core 5	(2191 feet)
Core 6	(2494 feet)
Core 8	(2913 feet)
Core 9	(3143 feet)
Core 11	(3682 feet)
Core 13	(4219 feet)
Core 14	(4558 feet)

Plate I



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To accompany Record No 1963/95

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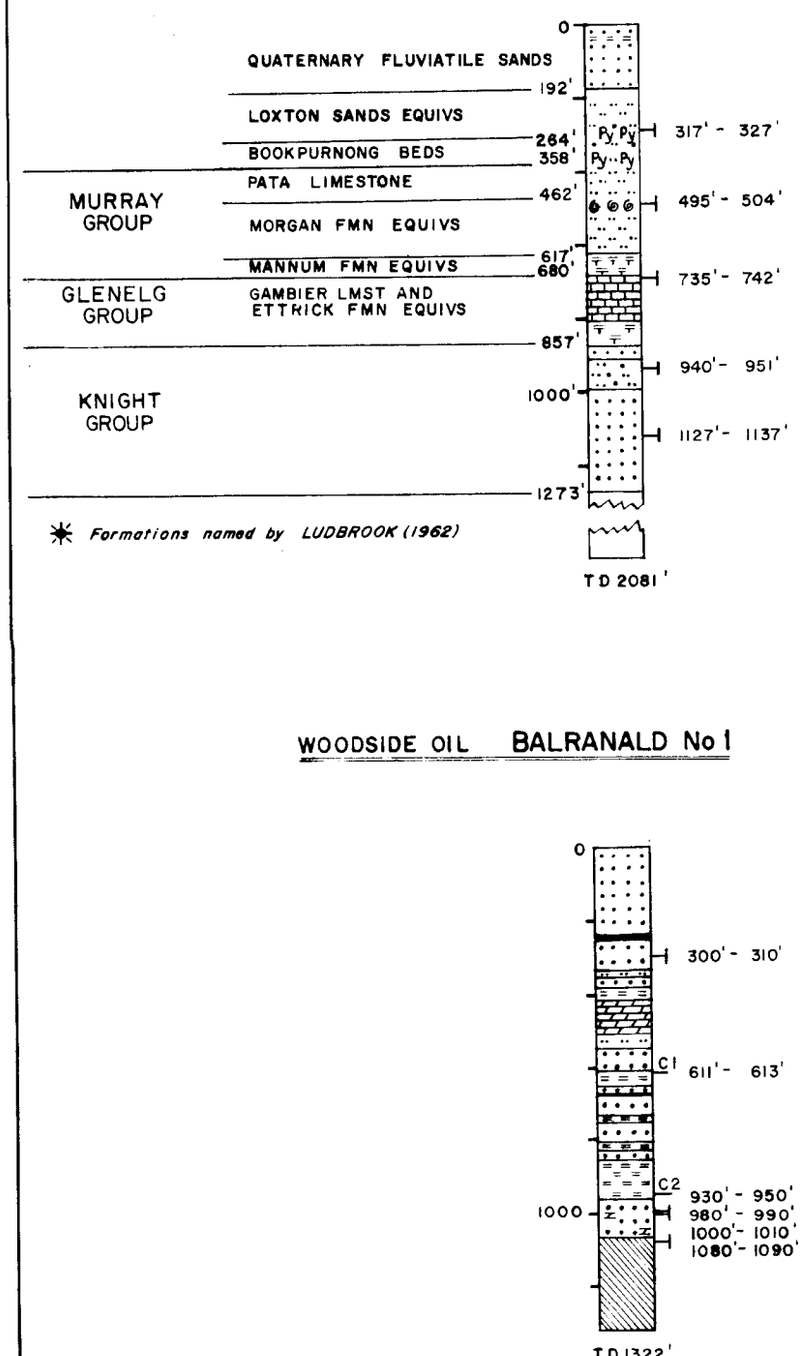
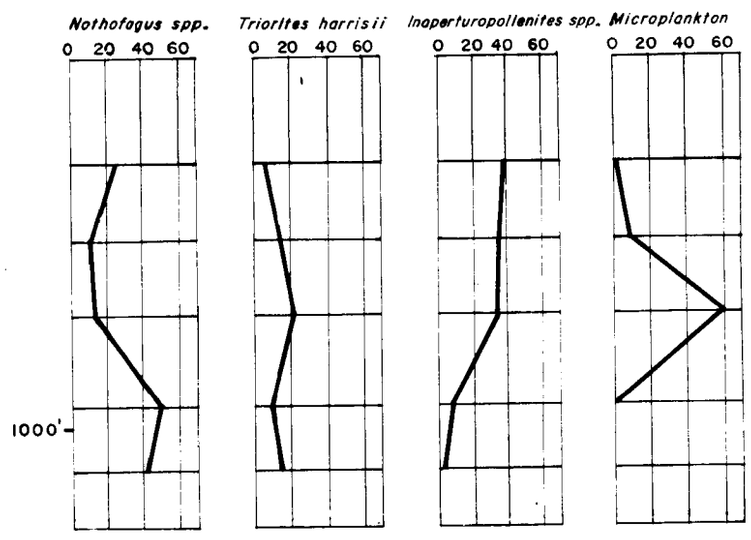
DISTRIBUTION AND RELATIVE ABUNDANCES OF SELECTED TERTIARY POLLENS IN A.O.G. WENTWORTH No 1, WOODSIDE OIL BALRANALD No 1 AND BUNDY No 1 WELLS

A.O.G. WENTWORTH No 1

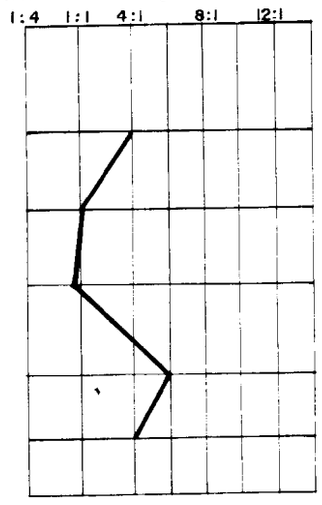


✳ *Formations named by LUDBROOK (1962)*

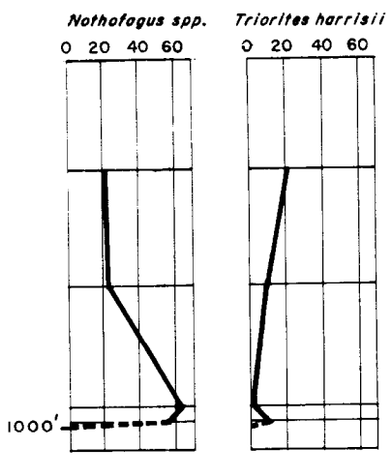
RELATIVE ABUNDANCE (%) OF SELECTED FOSSILS



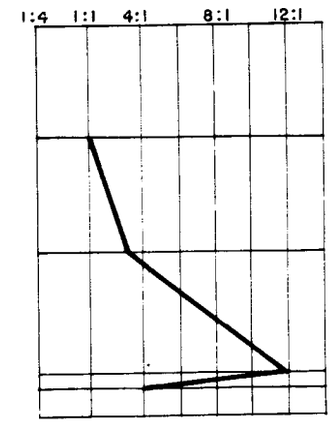
Ratio of *Nothofagus* to *Triorites harrisii*



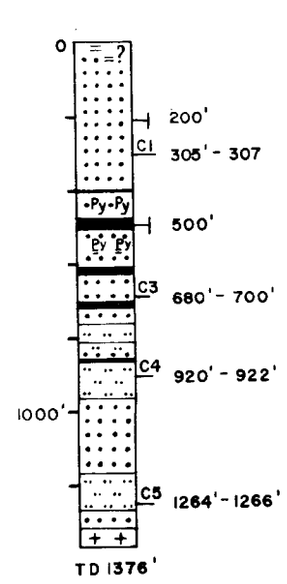
WOODSIDE OIL BALRANALD No 1

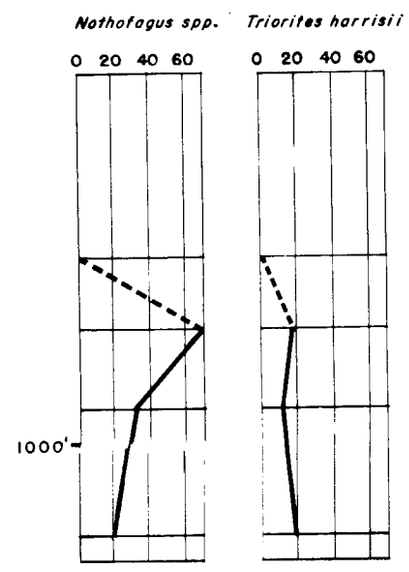


Ratio of *Nothofagus* to *Triorites harrisii*

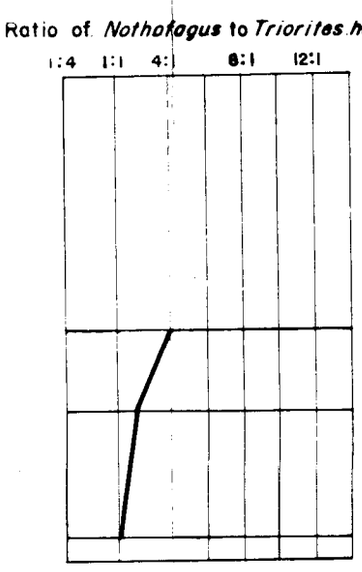


WOODSIDE OIL BUNDY No 1





Ratio of *Nothofagus* to *Triorites harrisii*



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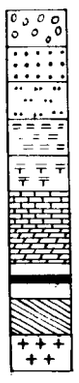

Conglomerate
Sandstone
Siltstone
Mudstone
Marl
Limestone
Dolomite
Coal or Lignite
Metamorphics
Granite

Py Pyritic

⑥ Shelly

Palynological Samples

C Core

Cuttings

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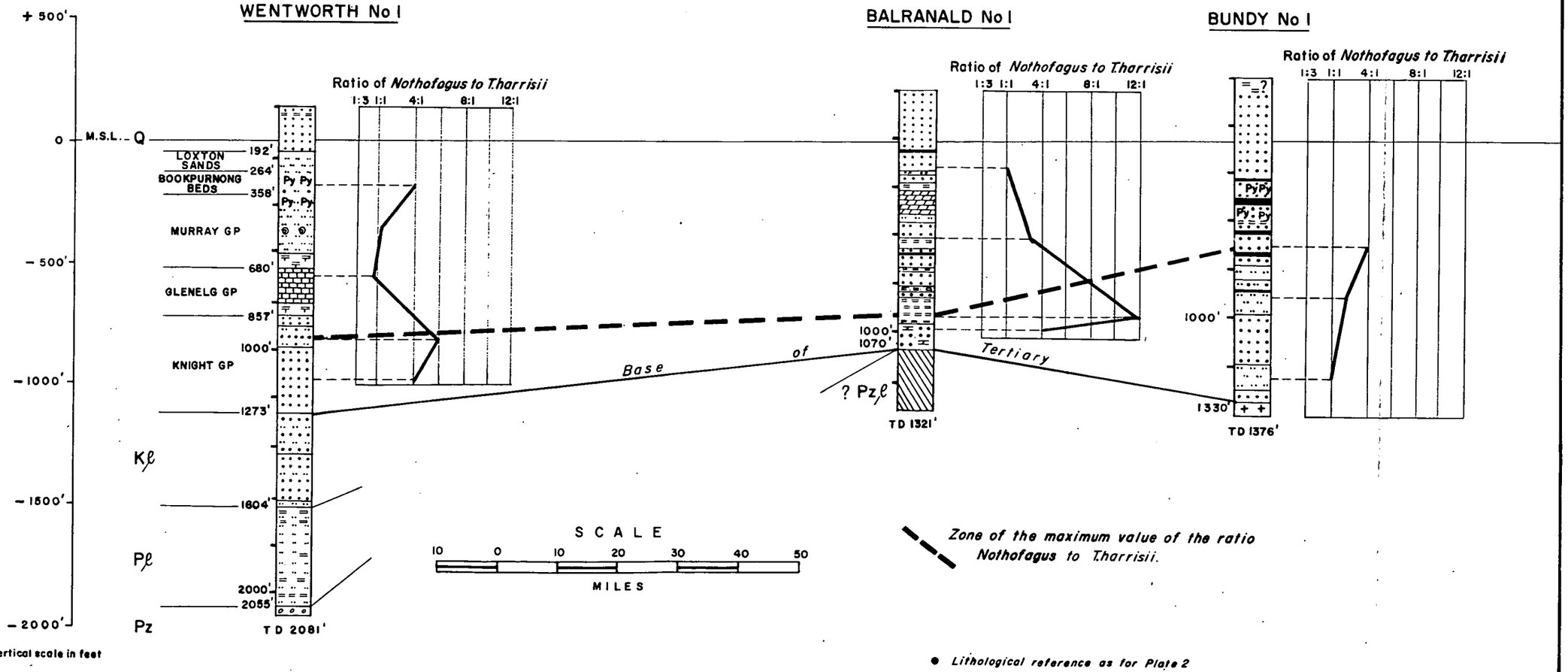
G.M.

TENTATIVE CORRELATION OF THE TERTIARY OF WENTWORTH No 1, BALRANALD No 1 & BUNDY No 1
BASED ON THE RATIO OF *Nothofagus* to *Triorites harrisii*



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