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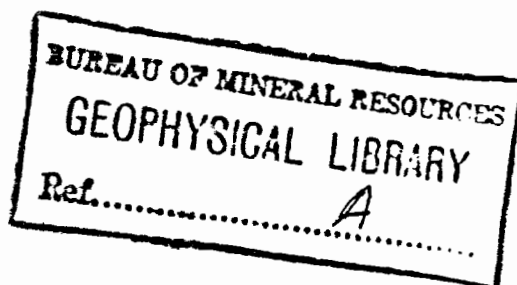
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BUREAU OF MINERAL RESOURCES
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1960/27



COMPLETION REPORT

STRATIGRAPHIC & STRUCTURAL BORES - MUDERONG, WESTERN AUSTRALIA

by

W.J. Perry

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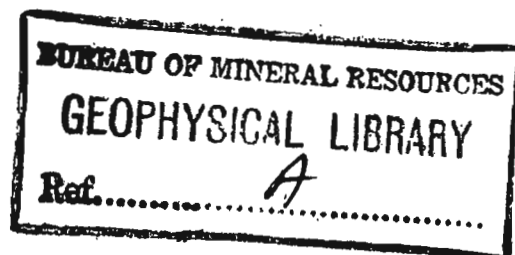
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SUMMARY AND CONCLUSIONS

Two bores with a total footage of 2,999 feet were drilled in the Middalya area of the Carnarvon Basin with the purpose of deciding whether the structural discordance known as the Middalya Fault is in fact a fault or an unconformity.

Correlation between bore holes has been made using lithology and the gamma ray logs, and this information, contrasted with the dips recorded in cores, leads the writer to the conclusion that a north-trending normal fault downthrown to the east between the two bores is the simplest explanation for the results.

Another important conclusion that may be drawn from this work is that the drilling of bores does not necessarily provide a unique solution to a structural problem of this nature.

Useful information about the character of the Byro Group in the sub-surface was obtained, including the discovery of the presence of residual wax.

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INTRODUCTION

The bores at Muderong were intended to provide information on the nature of the structural-stratigraphic discontinuities in the Carnarvon Basin; in particular information was sought on the nature of the contact exposed at the south-west of "Big Hill", about half a mile west of Muderong Bore (Text Fig. 1).

The original programme called for three shallow bores 800 to 900 feet apart in an east-west line, some two miles north of west of Muderong Tank. The westernmost bore A, was to be 750 feet deep and about 500 feet east of the inferred position of the contact, which was thought to dip east at a maximum angle of 30° . Bore B was to be 850 feet east of bore A and 1000 feet deep, and bore C 850 feet east of B and 1250 feet deep. The contract also required that ten feet of core be cut in each 100 feet drilled and that cuttings samples be taken at five foot intervals.

The contractors spudded the central bore B.M.R. 6 first, on 10th August, 1958 and this was completed at 1,002 feet on 19th August. Core No. 4 recovered from the interval 296-305 feet showed dips of 30° ; cores 100 feet above and below No. 4 had nearly flat dips, and it was concluded that a fault or unconformity had been intersected in Core No. 4. The projection of this inferred contact to the surface using a 30° dip intersected the surface east of the westernmost bore site, which consequently was not drilled. The available footage remaining in the contract (2,000 feet) was used in the easternmost bore B.M.R. 7 which was spudded on 21st August and completed on 14th September. For the purpose of the coring programme for B.M.R. 7, it was assumed that the 30° degree dip encountered in Core 4 of B.M.R. 6, represented an intersection with an unconformity surface "angle of rest" unconformity (Condon, 1956) - dipping 30° to the east. The distance between the two bores (929 feet) was measured by tape and the difference in R.T.E., 3', by Abney Level, and the depth to the inferred unconformity calculated; accordingly in B.M.R. 7 coring was started at 822 and continued to 848 feet with the object of coring through the inferred unconformity surface.

The holdes were drilled by a Bureau Failing Model 2500 Holemaster unit. Drilling bits were $5\frac{5}{8}$ " in diameter, and core bits $4\frac{3}{4}$ ". The contractors were Oil Drilling and Exploration Ltd.; the contract price was £4/12/6 a foot for drilling and £6/12/6 a foot for coring.

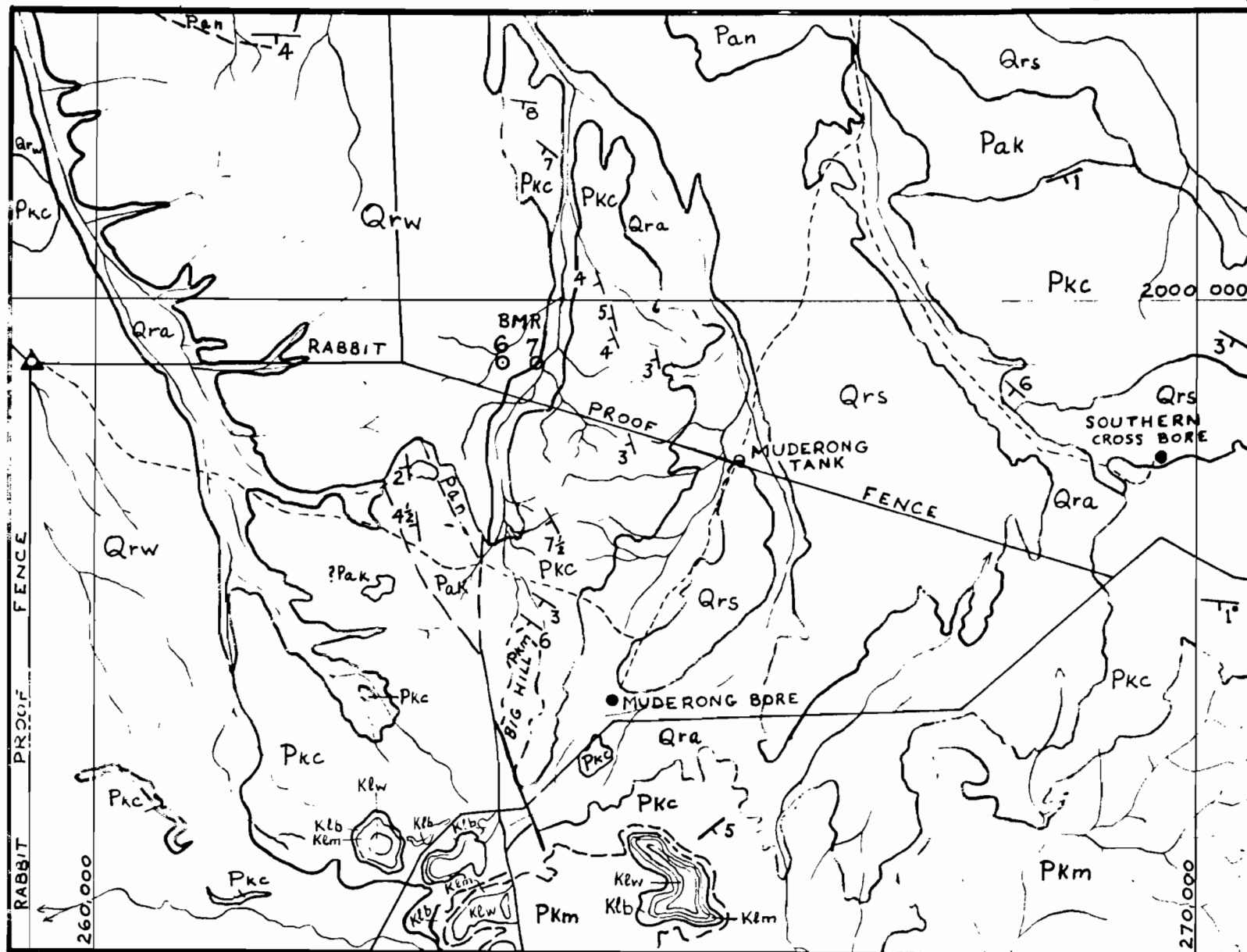
BORE HISTORY

1. General Data

Bore Name and No.	B.M.R. 6	B.M.R. 7
Location (map reference)	Kennedy : 264999 Range 24°5'55"S., 114°46'20"E.	Kennedy : 264999 Range (929 ft. E. of B.M.R. 6) 24°5'55"S., 114°46'30"E.
Permit area	27H	
Held by	West Australian Petroleum Pty. Ltd., Perth W.A.	
District	North-west	
Area	Middalya Station	Middalya Station
Total depth	1002	1997
Date spudded	10th August 1958	21st August 1958
Date completed	19th August 1958	14th September 1958.
Days actual drilling time	10	22½
Elevation (ground)	570' ±20' estimated from height of gravity stations	
-RTE	5' above surface 3' higher than B.M.R. 7	5' above surface
Status	abandoned	abandoned, cement plug placed at 437'.

2. Drilling Data

Name and address of drilling contractor	Oil Drilling and Exploration Ltd., Head Office 82 Elizabeth Street, C Sydney, N.S.W.	
Rig type and rating	B.M.R. Failing Holemaster 2500.	
Size of drill pipe drill collars Size and make of bits hole size.	<div style="display: flex; align-items: center;"> <div style="border: 1px solid black; padding: 5px; margin-right: 10px;"> 8½" 44' 5½" TD </div> <div> Hughes TC-OWS Corebits 4¾" Williams 3D Edeco M Reed 2C 1002' </div> </div>	<div style="display: flex; align-items: center;"> <div style="border: 1px solid black; padding: 5px; margin-right: 10px;"> 8½" 23' 5½" TD 1997' </div> <div> Hughes TC-OWS Edeco M Williams 3D Reed 2C 1997' </div> <div style="margin-left: 20px;"> Core bits 4¾" Reed H/F Reed S/F </div> </div>
Size of core heads core barrel pumps		
Drilling mud	water base-bentonite mud	Water base-bentonite mud.



Qra	alluvium	Winning	{Kew	Windalia Radiolarite	Pkm	Mungadan Sandstone	} Kennedy Group
Qrw	wash	Group	{Klm	Muderong Shale	Pkc	Coolkilya Greywacke	
Qrs	sand		Klb	Birdrong Formation	Pak	Baker Formation	} Byro Group
					Pan	Norton Greywacke	

SCALE



Water supply and conditions in hole Water trucked from Muderong Tank about 1 mile from bores.

Lost circulation particularly in Norton Gwke, at intervals indicated in composite log.

Plugs 6 sx. cement at 437' on completion.

3. Ditch cuttings

Sampled for both bores at 5 foot intervals.

4. Coring.

Original programme - 10 feet of core in each 100 feet drilled. This programme adhered to except in B.M.R. 7 in which extra coring was carried out for geological reasons - see introduction and composite log.

5. Side Wall coring:- Nil.

6. Electric logging.

Self-potential and resistivity logs run with a Widco 2000 unit.
Radioactivity (gamma ray) log " " " " "

7. Drilling time log:- see composite log. Time recorded for each 5 feet penetrated.

8. Formation tests:- Nil.

9. Deviation record taken with a Totco unit at following depths: (indicated in composite log).

B.M.R. 6.	302' 0°	B.M.R. 7.	200' 1½°
	609' 1½°		515' 10°
	792' 10°		775' 10°
	990' 1½°		999' 1¼°
			1400' 10°

10. Temperature records: Nil

No record below 1400 ft. - limit of catline.

GEOLOGY

General Statement

The area in which the bores were drilled lies in the north-central part of the Kennedy Range 4 mile sheet. Rocks of the Permian Byro and Kennedy Groups, and of the Cretaceous Birdrong Formation and Winning Group were mapped by B.M.R. geologists in 1952. (See Figure 1).

Previous work

Raggatt (1936, p.169) in his account of the geology of the North-West Basin named and described the Middalya Fault along the west side of the Kennedy Range; he regarded it as a normal fault dipping 70° to the west and involving both Cretaceous and Permian rocks.

Condon (1954, p.137) stated that the Middalya Fault dips at 30° to the east; he considered that Permian Coolkilya Greywacke had been thrust up over Lower Cretaceous Birdrong Formation and Muderong Shale, and that stratigraphical and structural evidence in the Permian rocks indicated that as far as Permian strata were concerned, the down-thrown block was to the east. According to Condon, two separate fault planes dipping in opposite directions can be seen five miles east-south-east of Paddy's Outcamp. Movement in late Palaeozoic time on the west-dipping fault caused a relative down-throw of the east block.

The relevant stratigraphy of the area (see Condon) is shown in Table 1, with slight modifications from Thomas and Dickins (1954, p.221).

Age	Group	Formation	Thickness (feet) Kennedy Range area		Lithology
Kungurian	Kennedy	Mungadan Sandstone	184		Quartz sandstone
		Coolkilya Greywacke	625		Quartz greywacke, greywacke.
?					
		Baker Formation	210		Siltstone, quartz greywacke
		Norton Greywacke	250		Greywacke, quartz greywacke
	Byro	Wandagee Formation	545		Siltstone, quartz greywacke
		Quinnanie Shale	85		Shale, thin quartz greywacke
Artinskian		Cundlego Formation	700		Quartz greywacke (some calcareous), siltstone.

Results of drilling

B.M.R. 7

Formations

Formation boundaries are fairly well defined in B.M.R. 7 and hence this will be considered first. Coolkilya Greywacke was drilled from surface to 190 feet; it is a grey very fine-grained quartz greywacke with minor amounts of dark grey siltstone. Below 190 feet the proportion of siltstone increases markedly and this is clearly shown in the radioactive (Gamma ray) log, which from 190 feet to 500 feet has high positive values; there is also a marked "break" in the S.P. log at 193 feet; from 350 to 500 feet quartz greywacke is virtually absent; the interval 190 to 500 feet is assigned to the Baker Formation. The thickness (310 feet) is greater than that of the section of 210 feet reported by Condon (1954, p. 89) about six miles north of the bores. In the bore, microfossils are rare in the Coolkilya Greywacke but the Baker Formation has a rich fauna.

At 500 feet the lithology changes to quartz greywacke and within a few feet to permeable sandstone which persists down to 740 feet; The gamma-ray log shows a sharp "break" at 501 feet and from there downwards is more variable but shows lower overall radioactivity; there is no "break" in the SP log and the SP values increase slowly to a maximum at 555 feet then decrease slowly down to 725 feet. However a log run on 6th September when the hole was at 1095 feet shows a marked "break" of 10mv in the positive direction between 495 and 505 feet; otherwise the shape of the SP curve is similar to that of the final log. The sandstone is light grey, micaceous, fine to very fine-grained with sub-rounded to sub-angular grains and clayey matrix, and is regarded as the Norton Greywacke. At the type section 18 miles east-south-east of the bores the Norton is medium-grained throughout its 235 feet, but two miles north-north-west of the bores it is a fine to very fine-grained micaceous quartz greywacke. (Johnstone, 1951, B.M.R. Field Note Book, 51DJ1, p. 80). The cores contain no microfossils. Circulation was lost four times in the interval 500 to 740 feet. The thickness of 240 feet is close to the approximate thickness of 250 feet at Paddy's outcamp recorded by Condon (1954, p.84).

The junction of the Norton with the Wandagee Formation is placed at 740 feet, below which the lithology changes to quartz greywacke with interbeds of siltstone. Both the gamma-ray and resistivity logs show a marked positive swing between 740 feet and 755 feet; above and below this swing the gamma-ray log has similar characteristics but below it has slightly higher average radioactivity. The SP log also shows slightly higher average voltages below 755 feet. There is no swing in the resistivity curve at 740 feet. From 740 to 1020 feet, light grey fine to very fine-grained micaceous quartz greywacke is interlaminated with dark grey to black claystone and siltstone, pyritic in places; quartz greywacke is dominant in the upper part of this interval, but below 920 feet only 30% of cuttings are quartz greywacke. Thin beds of calcareous quartz greywacke are present in places in the formation.

From 1020 to 1215 feet, the dominant lithology is black carbonaceous siltstone which grades into claystone in places, with minor discontinuous laminae of quartz greywacke. The siltstone is pyritic and contains a few grey calcareous slightly phosphatic nodules. This lithology is like that of the Quinnanie Shale, and the Wandagee-Quinnanie boundary can be placed at 1020 feet where there is a "break" in both the gamma-ray and SP logs. The interval 1020 to 1215 feet is characterized by high values of natural radioactivity comparable in magnitude with those of the Baker Formation.

Placing the base of the Wandagee Formation at 1020 feet and the Quinnanie-Cundlogo boundary at 1215 seems logical on lithological grounds. However it means that the thickness of the Wandagee is only 280 feet and that of the Quinnanie 195 feet. This is in striking contrast to the thickness measured in surface sections (Condon, op. cit., p. 81), though these have not been run close to the bores. At the head of Norton Creek some 20 miles to the east-south-east of the bores, the Wandagee Formation is 650 feet thick, and $4\frac{1}{2}$ miles north of Paddy's Outcamp, that is 7 miles north-west of the bores it is 800 feet thick. Also, at the head of Norton Creek the thickness of shale in the Quinnanie is 85 feet, and 5 miles north of Paddy's Outcamp it is 125 feet thick (Condon, MS, 1959, p.17).

The reason for the reduced thickness of the Wandagee Formation is not known. It may be that part of the section is actually missing, or that lateral variation of lithology is responsible for the different position of the formation boundary. The closest outcropping Wandagee Formation to the bores is $3\frac{1}{2}$ miles north where a thickness of about 180 feet of the sequence up to the junction with the overlying Norton Greywacke was mapped in 1951 (Johnstone, B.M.R. Field Note Book 51DJ1, p.79). The lithology is thin-bedded to laminated fine to very fine-grained micaceous quartz greywacke with small black siltstone lenses in places, interbedded with black gypseous siltstone. Lithology but not unit thickness has been recorded, so that the proportion of siltstone to quartz greywacke is not known, but from the scattered outcrop between observation points 626 and 627 (Johnstone, B.M.R. Field Note Book MJH/NW5/1951, p. 19) it may be inferred that lutite makes up about half the section. The thickness is estimated by the writer from measured dip and photo distance; the total thickness of the Formation, however, cannot be estimated because the lower part is obscured by sand. Strict comparisons between this partial surface section and the sequence in B.M.R. 7 below 750 feet cannot be made, but they appear to be quite similar.

Below 1215 feet the proportion of quartz greywacke to silty claystone increases, and the section comprises interbedded light grey fine to very fine-grained quartz greywacke and dark grey to black pyritic micaceous siltstone and claystone with a few thin calcareous quartz greywacke beds. The sequence from 1215 to the total depth of 1997 feet is assigned to the Cundlego Formation.

Structure

The structure evident in the cores is now considered in some detail. The Coolkilya Greywacke is flat-bedded, one piece of core No. 1 showed probable small-scale cross-stratification

Cores 2, 3, 4, and 5 were cut in the Baker Formation; these all showed flat bedding or low dips; in core 5 the dip may go up to 5 degrees, and there is cross-stratification dipping at 10 to 14 degrees. Core 6 is at the base of the Baker Formation; it has a dip of 6 degrees, and in it G.A. Thomas (pers. comm.) has identified Linoproductus cancriniformis and J.M. Dickins (pers. comm.) the pelecypod Streblopteria sp. nov.

The Norton Greywacke is represented by cores 7, 8 and 9. Core 7 shows small-scale cross-stratification over a length of three inches near the bottom; what appears to be true bedding ranges from flat up to 11 degrees within about four inches, and is evidently unreliable. In Core 8 the dip ranges from $3\frac{1}{2}$ degrees to 8 degrees; in Core 9 it ranges from 9 to 16 degrees but is probably cross-stratification. Foraminifera were not found in these cores.

Cores 10 to 15 inclusive are in the Wandagee Formation. Dips are variable within each core, for example in core 10 the dip of the top 3 inches of fine-grained quartz greywacke is 4 to 8 degrees; seven inches below this the dip on a calcareous quartz greywacke bed 18 inches thick is $10\frac{1}{2}$ degrees, and in non-calcareous quartz greywacke a few inches below this the dip is 15 degrees. Both these readings could be on foresets. Coring was continuous from 822 to 848 feet, this interval being made up of Cores 11, 12 13 of a cored length respectively of 10, 10 and 6 feet, and a recovered length of 3 feet, 1 foot 3 inches, and 1 foot 11 inches respectively. Core 11 of laminated very

fine-grained quartz greywacke and siltstone shows small-scale cross-stratification and minor slump contortion. True bedding is difficult to determine; it apparently ranges from nearly flat up to 10 degrees. Core 12 is of similar lithology to No. 11 and has a dip of up to 10 degrees. Laminated quartz greywacke and siltstone in Core 13 shows a dip up to 15 degrees but this is regarded as probable cross-stratification, as siltstone near the base of the core shows wavy bedding which as a whole appears horizontal.

Core 14 comprises interlaminated black siltstone and grey fine quartz greywacke, and shows small-scale slumping. The dip is from 18 to 20 degrees.

Plate 3 shows a piece from the top of Core 15; bedding is partly destroyed by burrowing organisms, and one burrow can be seen crossing the core from the middle right to the upper left of the photograph. Parts of the core unaffected by burrowing show a dip of 10 degrees. Few foraminifera were found in the upper part of the Wandagee Formation, though Ostracods and Brachiopod spines are present. Cores 15 to 18 however, all contain forams, which are abundant in Core 16.

From 1020 to 1215 feet the lithology is mainly dark grey carbonaceous siltstone and claystone, and between these depths the gamma ray log shows relatively high radioactivity corresponding in magnitude to that recorded from the Baker Formation. The dip of probable bedding in Core 16 ranges from 17 to 19 degrees, but no bedding was evident in Core 17. A few grey calcareous slightly phosphatic nodules are present in Core 16, and several species of foraminifera and some Ostracod and Brachiopod fragments were also found.

Core 18 shows small-scale cross-stratification and evidence of scour and fill, and of slumping; probable worm burrows are present. The bedding dip is up to 5 degrees. Small scale cross-stratification is common in Core 19 and probable worm burrows are present. Core dip is up to 5 degrees. The interval 1215 feet to total depth 1997 feet, in which cores 18 to 25 were cut, is assigned to the Cundlego Formation. The lithology is dark grey to black siltstone and silty claystone interbedded with light grey fine-grained quartz greywacke. Pyrite is fairly common throughout and thin calcareous beds are present in places.

Core 20 shows small scale slumping and cross-stratification in places; the bedding dip ranges from 3 up to 10 degrees.

Core 21 also shows small-scale cross-stratification and slumping, and the dip ranges from flat up to 5 degrees. Plate 4 illustrates the cross-stratification in laminated fine-grained quartz greywacke and also shows minor flowage at the boundary with the black siltstone near the bottom.

A piece of Core 22 from 1716 feet (Plates 5 and 6) shows the disturbed nature of the bedding at this depth; flowage, contortion, and brecciation are evident. Elsewhere in Core 22 cross-stratification and probable worm burrows are present. The dip of probable bedding is 5 degrees.

Core 23 is flat bedded; laminae of dark grey siltstone, black carbonaceous claystone and very fine quartz greywacke are slumped in places, and even where undisturbed most are discontinuous, as can be seen in Plate 7; this also shows one of the few calcareous nodules present in this core.

Cores 24 and 25 exhibit the same sort of minor slumping in places as the other cores from the Cundlego Formation. The bedding dip is flat.

B.M.R. 6

Formations

This bore passed from the weathered zone at about 40 feet into pale grey fine to very fine-grained micaceous quartz greywacke. In Core 1 it is laminated to thin-bedded ($\frac{1}{4}$ " to 1") and moderately permeable. Fine-grained to very fine-grained quartz greywacke with minor dark grey sandy siltstone lenses persists down to 250 feet. Burrowings are present in Core 3 (202-211 feet). The proportion of sandy siltstone in the cuttings increases from 10% at 250 feet to 80% at 190 feet. Core 4 (295-303) is coarse siltstone with fine-grained quartz greywacke lenses, the whole core being much affected by burrowing organisms. A formation boundary is placed at 285 feet where there is a positive swing in the gamma ray and SP logs. The sequence from surface to 285 feet has been assigned to the Norton Greywacke because its lithology is similar to that of the Norton in B.M.R. 7, because of its position in relation to the Wandagee Formation, and because to some extent the gamma ray log supports this correlation. The ground surface in the vicinity of the bores is almost entirely covered by a scree of silicified sandstone, but there is some evidence in support of the idea that the Norton Greywacke is at the surface in B.M.R. 6. Some 400 feet west of this bore brown fine-grained micaceous quartz greywacke that may be Norton Greywacke crops out in a creek; also, about 2,400 feet north by west from B.M.R. 6 and a hundred feet or so higher than the bore collar, is grey gypseous silty claystone that may be referable to the Baker Formation. The B.M.R. 6 sequence is siltier towards the bottom than the Norton Greywacke in B.M.R. 7 but it is still a fine to very fine-grained quartz greywacke. Near Wyera Well, 5 miles north-east of the bores, the Norton Greywacke is thin-bedded grey and brown very fine-grained micaceous quartz greywacke. It is also possible, however, that it is the Coolkilya Greywacke that is represented in B.M.R. 6. Half a mile north-east of the bores the Coolkilya is a very fine-grained micaceous quartz greywacke, with small black siltstone lenses, and in places calcareous lenses (Johnstone, 51DJ1, p. 82) so that its lithology is difficult to distinguish from that of the Norton in the vicinity of the bores.

From 285 feet to 350 feet grey to black siltstone is dominant, with subordinate thin lenses of fine-grained quartz greywacke. From 350 to 390 feet the siltstone is dark grey, hard, and calcareous and below 390 down to 580 feet the lithology is interbedded dark grey to black soft micaceous carbonaceous siltstone and subordinate light grey fine-grained micaceous quartz greywacke; a few light grey slightly phosphatic calcareous claystone nodules are present. The interval 285 to 580 feet is regarded as occupied by the Wandagee Formation. The thickness, 295 feet, is 15 feet greater than in B.M.R. 7.

From 580 feet to total depth the lithology is mainly dense firm dark grey to black micaceous siltstone with minor thin beds of light grey very fine-grained micaceous quartz greywacke. The cores show disseminated pyrite in the siltstone and the cuttings traces of calcite, and less commonly gypsum. This lithology is somewhat different from that of the Quinmanic Shale in B.M.R. 7 and in outcrop, and although the depth 745 feet appears to correlate by gamma ray log with the base of the

Quinnanie (1215 feet) in B.M.R. 7 there is not sufficient contrast in the lithology of the cores and cuttings between 580 and T.D. to establish a formation boundary. Consequently the whole interval is assigned to the Quinnanie Shale although it may include part of the Wandagee Formation. Small fragments of a black amorphous substance with a resinous lustre are found in the cuttings particularly between 700 and 750 feet. A piece of this material examined for West Australian Petroleum Pty. Ltd. by the Government Analyst, Western Australia, was described as residual wax or ozokerite.

Structure

The dip in Core 1 ranges from flat-bedded to $1\frac{1}{2}$ degrees. Core 2 was not recovered. Steeply-dipping joints and a probable small fault are present in Core 3, and burrowing organisms have been active in places. The attitude of bedding ranges from flat up to about 5 degrees.

Core 4 contains numerous burrowings and steeply dipping joints along which there has been a small amount of movement. There is small-scale slumping in places, and poorly developed bedding with a dip ranging from 19 to 30 degrees.

Core 5 is mainly siltstone with interlamination of very fine-grained quartz greywacke; minor slumps and burrowings have destroyed the lamination in places but elsewhere the dip ranges from flat up to 5 degrees.

The siltstone of Core 6 is also affected by burrowing organisms but where the bedding can be seen its dip ranges from 2 to 4 degrees.

Burrowings and small-scale slumps have destroyed much of the bedding in Core 7; where the dip can be measured it is horizontal or nearly so.

The dip of the siltstone in Core 8 ranges from horizontal to 5 degrees.

The siltstone of Core 9 is affected by burrowing organisms; the original bedding was probably laminated to very thin, but is now disturbed and contorted. However the bedding is still evident in places and the dip ranges from 3 to 5 degrees.

Core 10 is flat-bedded and the stratification has been affected by burrowings.

A few burrows are present in Core 11 in which the bedding is horizontal; small-scale cross-stratification is present, and small-scale slumping has disturbed the sediments in places.

Environment of deposition

The character of bedding in the Wandagee and Quinnanie and Cundlego Formations, for example, the preservation of fine lamination in some places, and scour and fill, discontinuous laminae and brecciation in other places suggests that the environment of deposition was one of intermittent turbulence. Such structures, more or less disturbed by burrowings, have been found in modern sediments on delta front slopes, and in the sheltered parts of delta platforms (van Straaten, 1959, p.213).

Shepard and Moore (1955, p.1529) in their study of modern sediments of Central Texas Coast have found that pyrite is common in places in the delta environment.

In the bores pyrite is common, much of it in disseminated grains and blebs in the siltstone and therefore regarded as syngenetic. However in Core 19, B.M.R. 7, (Cundlego Formation) small pyrite nodules are present in the quartz greywacke particularly along joint surfaces, and this fact is taken to indicate that some pyrite was formed after consolidation of the sediments and was free to move along the joints.

By analogy with modern sediments it is suggested that the sediments of the Wandagee Formation and below were deposited in the delta environment. The Norton Greywacke however, with its generally poor sorting, sub-angular to sub-rounded quartz grains and clayey matrix, was probably formed under different conditions, perhaps as a result of a difference in sediment supply or a change in position of the shore line. The return to lutite deposition in the Baker Formation may also have been caused by a movement of the shore line.

Correlation

The absence of definite marker beds in the area makes it necessary to rely largely on the electric and radioactivity logs. Although the logs cannot be matched exactly for more than a few feet the radioactivity logs afford reasonable correlation supported to some extent by the SP and resistivity logs and by lithology and microfossils.

Comparison of the gamma ray logs indicates that the Baker Formation, characterized in B.M.R. 7 by high and relatively uniform values of natural radioactivity between 190 and 500 feet is absent from B.M.R. 6. Also there is no lutite unit of this thickness in the upper part of B.M.R. 6.

The gamma ray and resistivity logs in B.M.R. 7 between 518 and 728 feet may be doubtfully correlated with the logs between 68 and 268 feet in B.M.R. 6. This lends support to the idea that Norton Greywacke is at the surface in B.M.R. 6. On the other hand there is a possible correlation of 70 to 265 feet in B.M.R. 6 with 80 to 275 feet in B.M.R. 7, in both radioactivity and resistivity logs, which supports the idea that Cookkilya Greywacke occupies the upper part of the bore in B.M.R. 6.

The depth 762 feet in B.M.R. 7 matches reasonably well by gamma ray log with 335 feet in B.M.R. 6 (Fig. 2) and the interval between 850 and 1220 feet in B.M.R. 7 has the same general form as the interval between 420 and 750 feet in B.M.R. 6. Thus there is little doubt about the correlation of the Wandagee and Quinnanie Formations. However it should be pointed out that match of both radioactivity and resistivity logs can be made between the intervals 862 to 998 feet in B.M.R. 6 and 790 to 920 feet in B.M.R. 7 (Fig. 3); this would make the whole interval between 285 and 1002 feet Wandagee Formation and give an aggregate thickness for that formation of 813 feet which agrees with the thickness measured 7 miles north-west of the bores.

Below 1220 feet in B.M.R. 7 matching is poor; the depth 1450 feet in B.M.R. 7 possibly corresponds to 970 feet in B.M.R. 6.

Two possible interpretations of the structural data are advanced; first, the fault interpretation and second, the depositional interpretation.

Fault interpretation

Here Norton Greywacke is regarded as the formation from surface to 285 feet in B.M.R. 6. Referring to Text Fig. 2, it can be seen that the lines joining points correlated by the gamma ray logs dip at $29\frac{1}{2}$ and 27 degrees respectively. Within the interval so correlated the dips of bedding in cores from B.M.R. 6 are nowhere higher than 5 degrees. Within the same interval in B.M.R. 7 probable bedding dips range from 10 to 19 degrees. Whether these figures are true bedding dips is doubtful. To the writer it seems likely that the whole sequence is only gently dipping, probably about 5 degrees. Slumping is all of small scale and is found in many cores in which there is cross-stratification too; possibly the slumping occurred down foreset slopes at places where instability was caused by changes in current velocity.

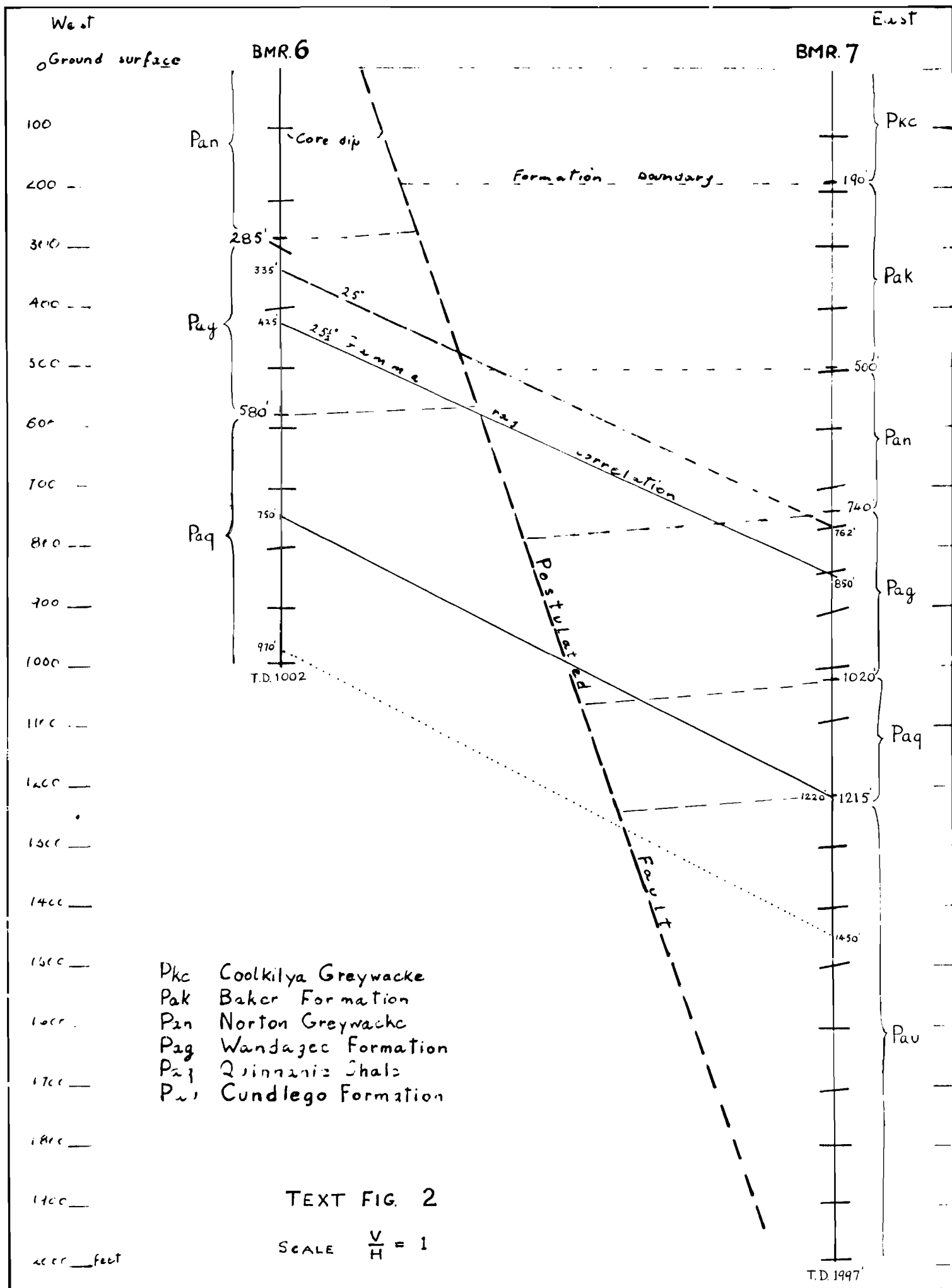
A fault between the bores is postulated as an explanation for the discrepancy in the dip in Core 4 (B.M.R. 6) of 19 to 30 degrees can be regarded as having been produced by an offshoot of the fault, which is thus considered to be closer to B.M.R. 6 than B.M.R. 7 at this level; the fault is thus represented as a normal fault dipping east.

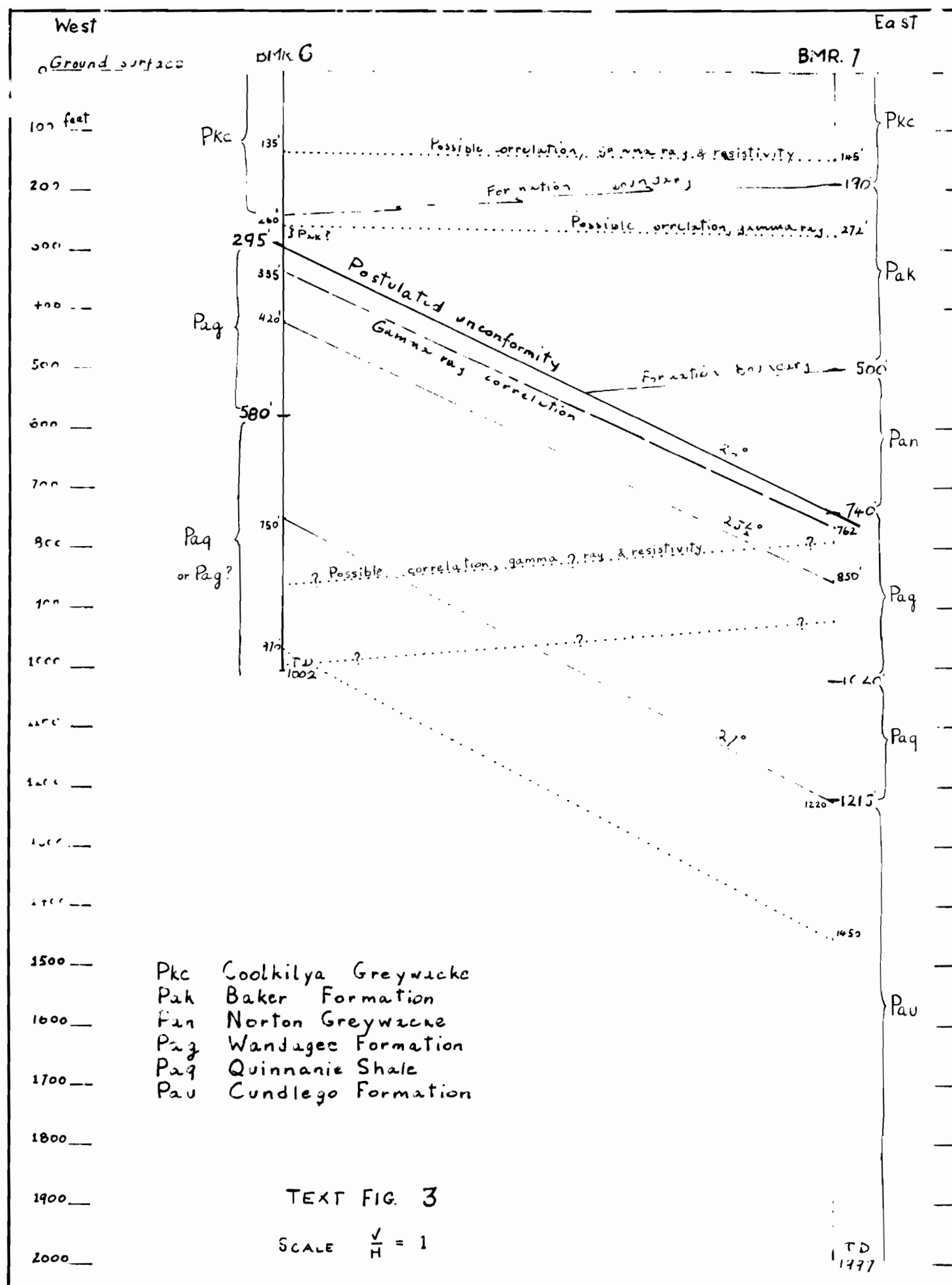
The Wandagee Formation is thinner in both bores than might be expected from measurements of surface sections. Assuming that there is little lateral variation in thickness of the formation as a whole, the difference in thickness in the bores might be explained by a normal fault dipping east at about 40 degrees, cutting the Wandagee almost in half and throwing the upper part down to the east. It is evident however that this explanation is untenable because the bore sections correlate quite well by the gamma ray logs, and this would not be so if the formation had been faulted in the manner described. On the other hand if Wandagee Formation continues from 285 feet to T.D. in B.M.R. 6 and the alternative log match is valid no displacement of the Wandagee Formation between B.M.R. 6 and B.M.R. 7 is necessary but the Baker and Norton are absent from B.M.R. 6.

If a fault interpretation is adopted to explain the structure, then it must be assumed that for reasons unknown the Wandagee Formation is relatively thin in the area of the bores.

Depositional interpretation

This interpretation postulates that B.M.R. 6 passed through an "angle of rest" unconformity (Condon, 1956, p.) in or near Core 4 (295-305 feet). The unconformity surface is thought to dip east at about 30 degrees (Text Fig. 3); however the gamma ray 'correlation' of 335 feet (B.M.R. 6) with 762 feet (B.M.R. 7) is fairly reliable, and hence the unconformity surface as a whole dips at a shallower angle than 30, probably about 26 degrees. If the correlation of 260 feet (B.M.R. 6) with 272 (B.M.R. 7) is accepted, it is probable that the Baker Formation is represented in B.M.R. 6 as indicated in Fig. 3. The Norton Greywacke wedges out against the unconformity. The unconformity surface truncates the Wandagee Formation in B.M.R. 7, and is responsible for its reduced thickness.





However it is not clear from this interpretation why the Wandagee is approximately the same thickness in B.M.R. 6, and why the particular sequence in B.M.R. 7 correlates with the sequence in B.M.R. 6, and why, if that is so, in B.M.R. 6 the Quinannie Shale is coarser-grained whereas the Wandagee Formation is finer grained than in B.M.R. 7. It would be expected from the angle of rest hypothesis that the sequence in B.M.R. 6 would be stratigraphically higher than that in B.M.R. 7, but from the gamma ray logs this apparently is not so. There is therefore still the difficulty of reconciling the relative positions in the bores of the Wandagee Formation and Quinannie Shale with the core dips.

The gamma ray correlations 420 feet (B.M.R. 6) to 850 feet (B.M.R. 7) and 750 feet (B.M.R. 6) to 1220 feet (B.M.R. 7) indicate that if these correlations are valid and if the beds between these respective points are continuous then average dips of $25\frac{1}{2}$ and just over 27 degrees must be assigned to them. As the dips in both bores are less than these (19 degrees maximum) any continuous bed must have a dip greater than these values somewhere between the bores. As the slope of the 'angle of rest' unconformity surface is about 26 degrees then slumping would occur at slopes of this or steeper angles in sediments of similar composition and grain size such as are found lower in the Wandagee Formation and Quinannie Shale. Slumping would destroy the continuity of beds and the possibility of correlation by the gamma ray logs.

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BORE BMR 7 MUDERONG

STATE WESTERN AUSTRALIA

BASIN: CARNARVON

AREA: MUDERONG (MIDDALYA STATION)

LOCATION Latitude 24° 5' 55" S

ELECTRIC LOG DATA:

LITHOLOGY - SYMBOLS

Longitude 114° 46' 30" E

DATE 14th Sept 1958

INTERVAL LOGGED

QUARTZ GREYWACKE

SILTSTONE

CLAYSTONE

SHALE

ELEVATION: Ground 570±20' estimated from height of Rotary Table 5' above surface. gravity station

M.C. NATURE Clay-base

DENSITY: 73 lbs. per cub. ft.

VISCOSITY: 385

REFERENCE

MACROFOSSILS

RESIDUAL WAX

CALCAREOUS

LOST CIRCULATION

DATE SPUN: 21st. Aug. 1958

COMPLETED 14th Sept. 1958

TOTAL DEPTH (From R.T.) 1997 ft

STATUS: Abandoned

HOPE PROJECT

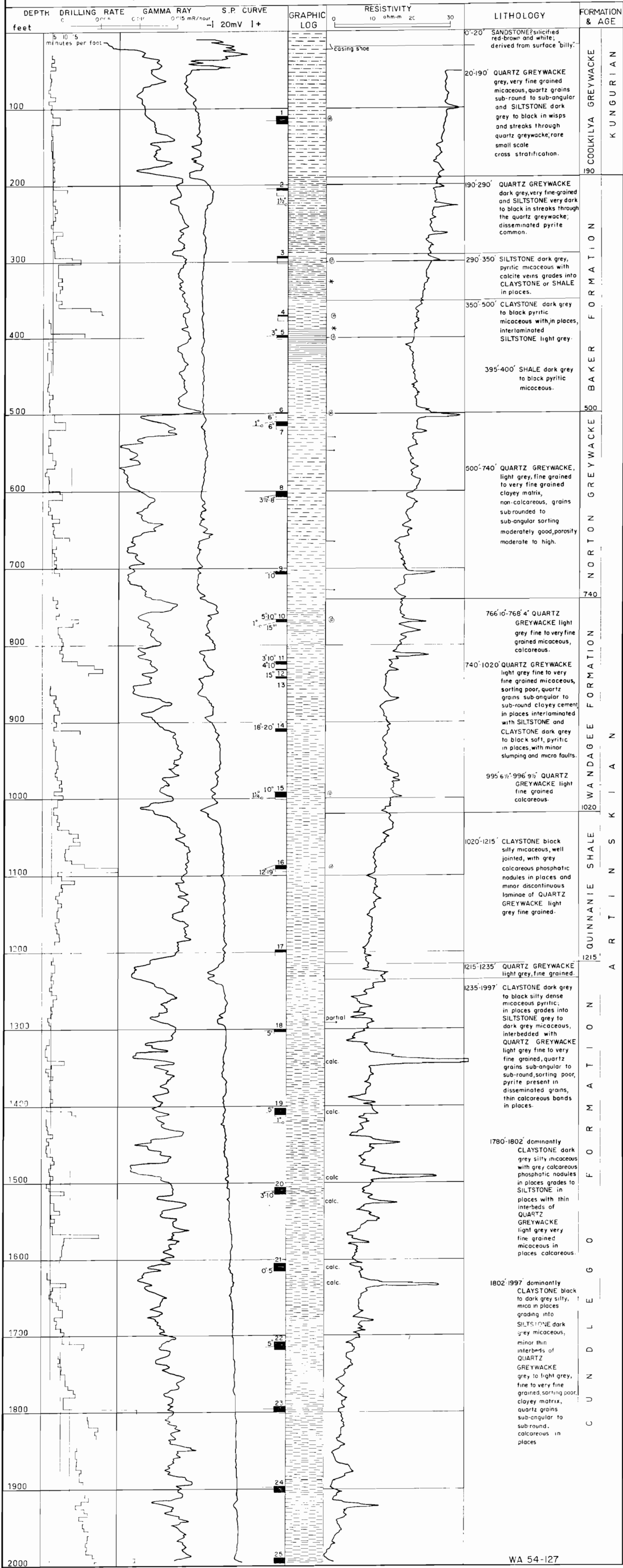
OTHER LOGS

DEVIATION: — 0

CASING: 5-23 ft

PLUGS

LITHOLOGY BY: W.J. Perry



BORE BMR.6 MUDERONG

STATE: WESTERN AUSTRALIA	BASIN: CARNARVON	AREA: MUDERONG (MIDDALYA STATION)
LOCATION: Latitude 24° 5' 55" S. Longitude 114° 46' 20" E.	ELECTRIC LOG DATA DATE: 19th Aug. 1958	LITHOLOGY SYMBOLS QUARTZ GREYWACKE -----
ELEVATION Ground: 570'±20' estimated from height of Rotary Table: 5' above ground, 3' gravity stations.	INTERVAL LOGGED 1002-45 ft.	SILTSTONE -----
DATE SPUDDED: 10th Aug. 1958 higher than B.M.R.7.	MUD - NATURE: Clay-base	REFERENCE
COMPLETED 19th Aug 1958	DENSITY: 80-90 lbs per cub. ft.	MEGAFOSSILS Ⓞ
TOTAL DEPTH (From R.T.) 1002 ft.	VISCOSITY: 41S	RESIDUAL WAX *
STATUS: Abandoned.	RESISTIVITY: 1-5 ohm-m at 72°F	CALCAREOUS calc.
HOLE PROFILE 5-44 ft: 8 1/2" 44-1002 ft: 5 5/8"	OTHER LOGS DEVIATION —○—	
CASING: 5-44 ft		
PLUGS		
LITHOLOGY BY: SP. Willmott & WJ. Perry	(ELECTRIC LOGS PROVISIONAL ONLY)	

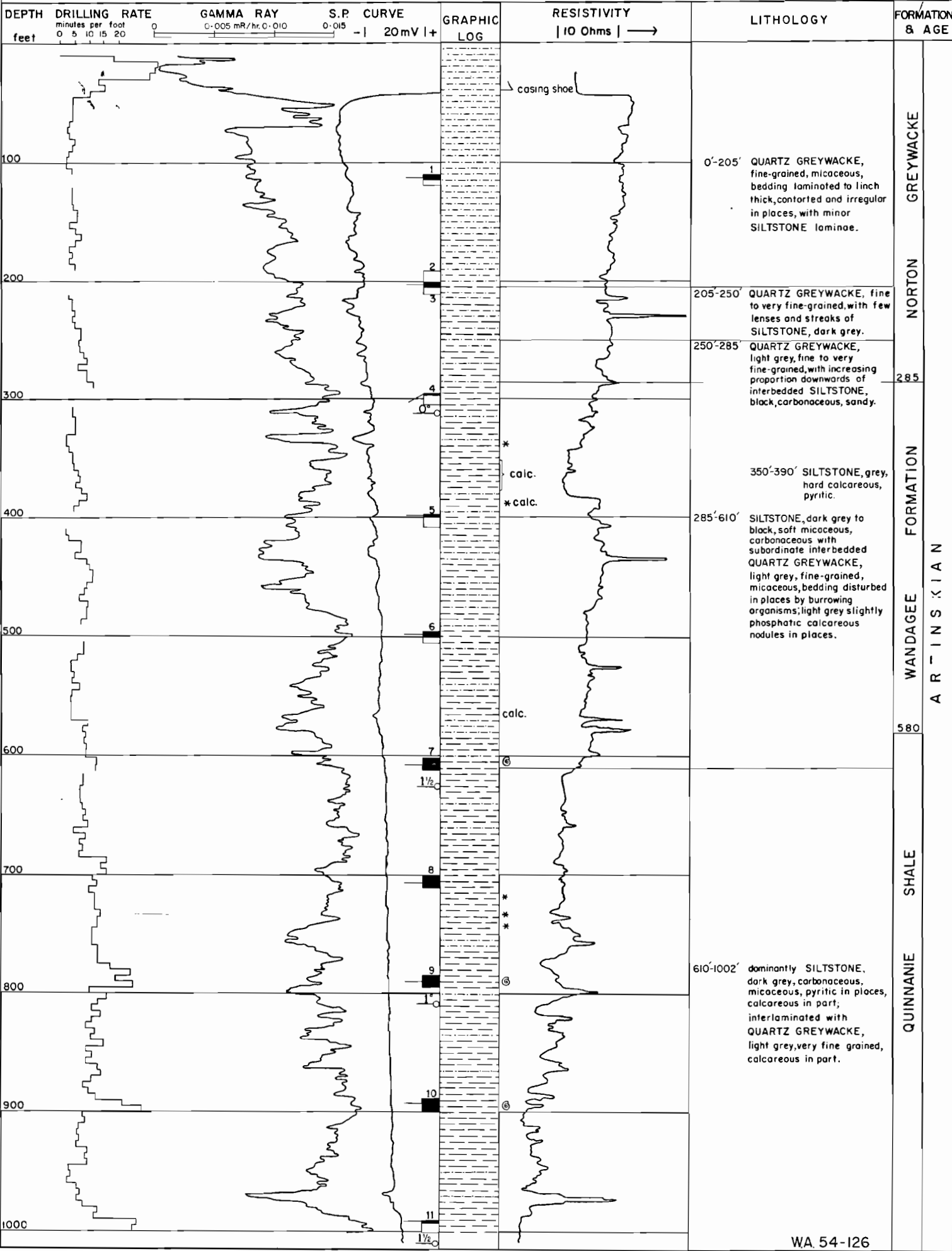
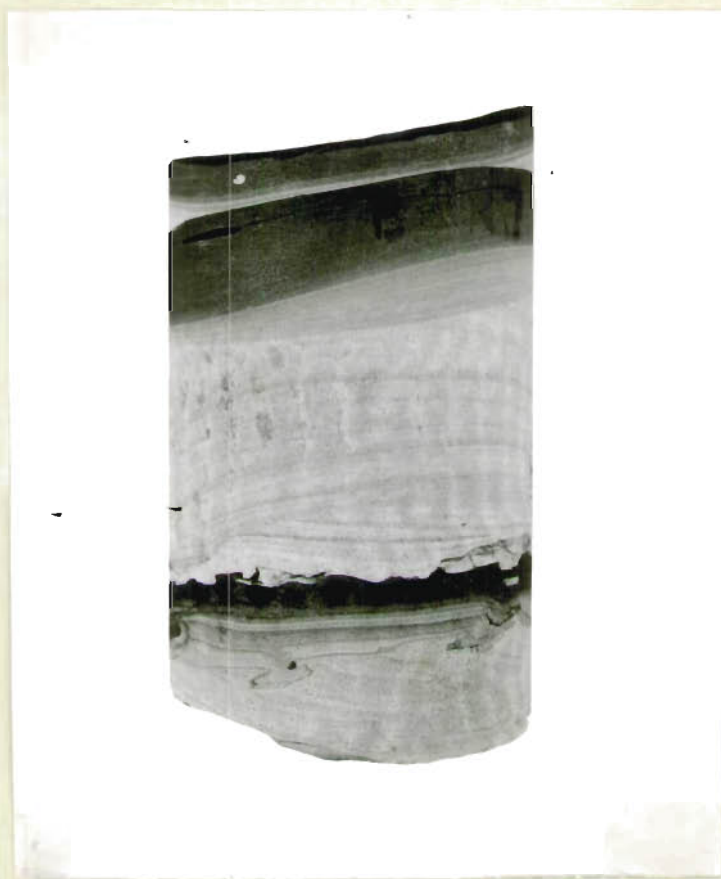


PLATE 3



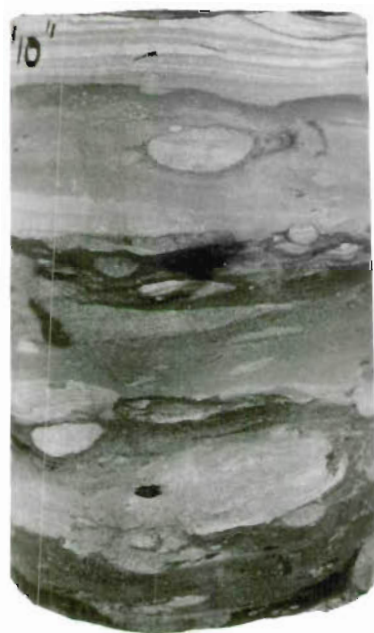
Approx. natural size

Bedding partly destroyed by burrowing organisms; worm burrow runs from middle right to upper left. Probable slump brecciation also, which has produced wisps of one lithology in the other.



Approx. natural size

Cross-stratification in laminated quartz greywacke;
slight flowage above black siltstone near
bottom of core.



Approx. natural size

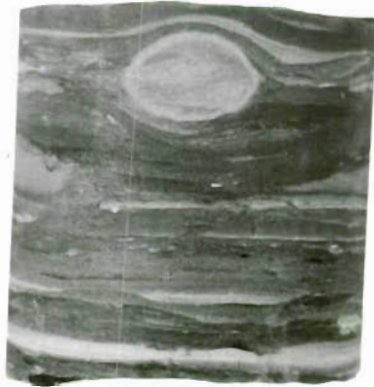
Probable flowage of material at the base
of some fine quartz greywacke layers.

PLATE 6



Approx. natural size.

Local brecciation of thin layers of quartz
greywacke and siltstone.



Approx. natural size.

Calcareous nodule in laminated dark grey siltstone
and light grey very fine-grained quartz greywacke.