COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

PETROLEUM SEARCH SUBSIDY ACTS
Publication No. 6

023663

PURI No. 1 WELL, PAPUA

OF

AUSTRALASIAN PETROLEUM COMPANY PTY LTD

Issued under the Authority of Senator the Hon. W. H. Spooner,
Minister for National Development
1961

COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

Minister : SENATOR THE HON. W. H. SPOONER, M.M.
Secretary : H. G. RAGGATT, C.B.E.

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

Director : J. M. RAYNER

This Report was prepared for publication in the Geological Branch

Chief Geologist: N. H. FISHER.

CONTENTS.

ILLUSTRATIONS.

INTRODUCTION.

This publication presents the scientific and technical results obtained from the drilling of a deep test well at Puri in Western Papua, by the Australasian Petroleum Company Pty Ltd. These results were originally submitted by the company in a completion report on the well, written in two parts:

Part I, Geology, by C.E.P. Hull, which includes a report on the palaeontological examination of samples from the well, by F.C. Dilley.

Part II, Petroleum Engineering, by M.W. Clegg, including the information obtained from testing and the results of oil, gas and water analyses.

This information has been combined into one volume. The authors of the various chapters are indicated in the table of contents.

The formal Papuan stratigraphic nomenclature is at present being studied by the geological staff and advisers of the Australasian Petroleum Company Pty Ltd in London.

As this study is not complete, the stratigraphical names in common use by the operating company have not been submitted for the formal approval of the Australian Stratigraphical Nomenclature Committee. Accordingly, within this report Miocene stratigraphical units are designated by informal geographical stage names and an appropriate lithological term. The Eocene and Cretaceous sediments encountered in the well are not subdivided but are merely referred to a Eocene limestone and Cretaceous shale. The Miocene in the Puri area is subdivided into the following stratigraphical units:

"Muruan" mudstone - Upper Miocene

"Ivorian" marl - Middle Miocene

"Taurian" limestone - Lower Miocene

"Kereruan" limestone - Lower Miocene

Two deviated holes, Puri No 1A and Puri No 1B, were drilled from Puri No 1, but as these were not subsidized under the Petroleum Search Subsidy Acts, information from these holes is not included in this report.

PERTINENT WELL DATA.

Location:	07°06'24"S 144°59'56"E
R.T.E.:	340' A.S.L.
Rig:	National 50 (Helirig)

Mast: Lee C. Moore 132' Jack-knife

Pumps: 2 x N.S. Co. C150B 12" stroke on hole
1 x N.S. Co. C150B 12" stroke Mixing Tank

Service: By S58 Helicopters only

Spud Date: 29th October 1957

Completed Drilling: 7th August 1958

Completed Testing Programme: 22nd December 1958 (below 7360 feet)

* 16th September 1959 (above 7360 feet)

Casing: 18 5/8" parted and slipped, shoe at 670 feet, 9th November 1957.

13 3/8" shoe at 2099', 16th January 1958.

9 5/8 shoe at 6880', 10th May 1958.

7" Liner at 7450' with hangar at 6808', 7th September 1958.

5" Liner at 8200' with hangar at 7389', 28th September 1958.

Formation Tops:

"Ivorian" marl	From Surface
"Taurian" limestone	175 feet
"Kereruan" limestone	1506 "
Eocene limestone	1762 "
Cretaceous shale	2022 "
Cretaceous siltstone	6259 "
"Taurian" limestone (repeated)	7425 "
"Kereruan" limestone (repeated)	7788 "
Eocene limestone (repeated)	8036 "
Cretaceous siltstone	8928 "
Final Total Depth	10,100 "

---

* Operations were suspended from 23rd January 1959 to 1st September 1959 in order to drill two sidetrack holes.

Summary of Tests:

1. Sub-thrust Limestones: 23 tests were made in the limestone interval 7425-8897 feet. The interval 7460-7508 feet produced oil at a maximum rate of 1610 bbl/day, which declined over 9 days to a rate of 34 bbl/day. Final production rates were 0.33×10^6 cubic feet gas, trace oil, and 1650 bbl brine (14,210 ppm NaCl) per day. Hydrocarbons were proved absent below 8200 feet.

2. Over-thrust Limestones: 7 tests were made through perforations of the intervals 1760-1780 feet, 1850-1870 feet, 1960-1968 feet and 1980-1996 feet. The tests showed the absence of oil and the presence of brine (13,000 - 28,000 ppm NaCl) with a small amount of gas containing less than 1% ethane plus higher hydrocarbons.

Plugs:

1. Cement plug with top at 8897 feet.
2. 5" Baker Type "N" Bridge Plug at 7520 feet.
3. 7" Baker Type "N" Bridge Plug at 7360 feet.
4. Cement plug with top at about 6105 feet. (Puri Well No. 1A sidetracked through a window in the 9 5/8" casing from 6091/6105 feet).
5. 9 5/8" Baker Type "K" Bridge Plug at 3995 feet.
6. Cement plug with top about 3870 feet. (Puri Well No. 1B sidetracked through a window in the 9 5/8" casing from 3855 to 3901 feet).
7. Cement plug with top at 2070 feet.
8. Cement plug from 1785 to 1630 feet.
9. Cement plug from 200 to 50 feet.

Note: Puri Well No. 1A 7" liner hanger is at 5855 feet in the Puri Well No. 1 9 5/8" casing.
Puri Well No. 1B 7" liner hanger is at 3670 feet in the Puri Well No. 1 9 5/8" casing.

SUMMARY OF OPERATIONS.

Puri No. 1 well was spudded-in on 29th October 1957, using a high pH mud, and a 17½" hole was drilled to 353 feet, where circulation was lost completely. Attempts to regain circulation using sealing agents and local clay mud were not successful, and after a bailing test had indicated a steady fluid level in the hole 190 feet from surface, the hole was deepened to 510 feet without returns. After reaming the hole to 23" a string of 18 5/8" casing was run, and cemented at 506 feet with 10 tons of 1.7 S.G. cement. It was necessary to fill the annulus from the surface with 265 cubic feet of concrete.

After the 18 5/8" casing shoe had been drilled out with a 17½" bit, mud was lost at 512 feet and, although this loss was remedied, a complete loss occurred at 540 feet and circulation could not be regained. A 12¼" hole was drilled to 2110 feet, using water plus slugs of local clay mud, and then reamed out to 17½". Numerous twist-offs occurred while this section of the hole was being drilled and reamed, and the pipe frequently wound up. Whilst opening out the 12½" hole to 17½", the bit held up at 758 feet when running in and was worked free after spotting diesel oil and acid to the bit. On January 2nd on a subsequent round trip the 17½" bit held up at 359 feet in the 18 5/8" casing, but it was found that by turning the pipe the bit would pass. The Schlumberger logs which were run over this section of the hole indicated that the 18 5/8" casing had parted, the break being from 211 feet to 370 feet, with the bottom joint at 668 feet.

13 3/8" x 68-lb casing was run on January 13/14th, but it was found impossible to circulate through the casing because of the plugging, by sealing agents, of the differential fill-up collar. This was drilled and milled out and the casing cemented with 50 tons of 1.71 S.G. cement slurry with the shoe at 2099 feet. No returns were obtained at the surface, and a temperature survey showed the top of the cement behind the 13 3/8" casing to be at 1210 feet.

When the 13 3/8" casing shoe had been drilled out the water in the hole was replaced by a brine-starch-oil emulsion mud of 1.50 S.G. to drill the Cretaceous mudstones. Initial progress was very slow because of an obstruction thought to be part of the 18 5/8" casing shoe. Successive runs with a Zublin bit, junk basket, magnet, mill, and impression block were ineffective in recovering the junk. On 29th January the junk was by-passed and normal drilling was resumed; no further evidence of the junk was noticed. The mudstones were drilled without further incident, using a 1.5 S.G. salt-saturated mud with 10% diesel oil, down to 6917 feet, when it was decided to run casing. Frequent pull-backs while drilling these mudstones kept the hole in good condition, and only the bottom 200 feet of hole at any time caused drags when pulling back. Schlumberger logs consisting of standard electric, microlog-caliper, laterolog, and gamma ray-neutron logs and a photo-inclinometer survey were run prior to setting the 9 5/8" casing at 6880 feet on May 9th. The casing was cemented on May 10th with 117 tons of 1.7 S.G. "Starcor" oilwell cement. Returns to surface were not obtained, and a temperature survey indicated that the top of the cement in the annulus was at approximately 3000 feet.

After the 9 5/8" shoe was drilled out and the hole tested to 500 p.s.i. with 1.5 S.G. mud, drilling and coring continued. Great difficulty was experienced in keeping deviation below 5°, and two stabilizers were run in the drill string, 60 feet and 120 feet above the bit. This was found to make little difference, and the stabilizers were removed and one stand only of drill collars (89 ft. 3x6 1/4" OD x 2 7/8"ID) used with correspondingly light weight. This too appeared to have little effect, but at 7425 feet the well re-entered limestone and the hole deviation was reduced over 800 feet from 5° to 2°, and thereafter remained fairly constant at 2°. Mud was lost at several places in the limestone, mainly at 7504 feet, 8504 feet and 8824 feet, the latter two being complete losses which were sealed off with lost circulation material. Mud was lost intermittently throughout the remainder of the drilling down to total depth, but these losses may not have been on bottom. During drilling in the limestone the mud weight was reduced to 1.45 S.G., but it was considered inadvisable to reduce it any further because of the exposed siltstones and mudstones above.

At 8928 feet the well again entered siltstone, and at 9143 feet Schlumberger electrical log was run from bottom to the 9 5/8" shoe, 5" liners were fitted to the pumps, and, to reduce the weight of the drill string, 25 stands of 3½" extra heavy drill tubing were run and the number of drill collars reduced to 9, the Cameron S.S. Blow-out Preventor being fitted with 4½" and 3½" rams.

Below 9000 feet it was observed that the blockline was wearing to excess, and time was lost in respooling, cutting, and replacing blocklines.

On drilling ahead, difficulty in keeping the hole straight in the siltstone succession was again experienced and deviations of up to 6°45' were recorded in spite of controlled weight and bit revolutions.

On July 24th after pulling out it was found that a cross section core and 3" of the shank of the 8½" Reed T bit had been left in the hole after a total drilling time of 18½ hours at 120 revolutions with 10,000-15,000 lb weight.

The fish was recovered after three runs with a Globe Junk Basket, two runs with a magnet, and one run with a Zublin bit. An attempt to run a Servco Millhead was abandoned when it held up in the casing at 5880 feet.

The hole was deepened to a final depth of 10,100 feet, and gamma ray-neutron, laterolog, micro-caliper and further electric logs were run. Three runs with the Schlumberger sidewall coring gun were made over the intervals 7730-7760 and 8040-8060 feet, but recovery was generally poor.

The hole was plugged back to 8897 feet, and the major loss zones at 8504 feet and 8824 feet tested in open hole. A further plug was set at 7551 feet and the top of the limestone tested by setting a packer in the 9 5/8" casing shoe (at 6880 feet): gas was produced but the mudstones bridged during the test. The hole was cleaned out down to 7551 feet and a Schlumberger caliper survey indicated considerable hole enlargement over the section 6880-7425 feet. The 7" liner was run and cemented at 7450 feet with the hanger at 6808 feet. After the shoe was cleaned out, successive sections of open hole were tested down to 8307 feet, and a 5" liner cemented at 8200 feet, with the hanger at 7389 feet. Drill-stem testing was then continued in the 5" liner, the casing being perforated with Schlumberger shaped charges, and intervals tested with either conventional casing or straddle packers. Tests 6 to 8 (see page 32) were made below the 5" liner shoe, and all subsequent tests (Nos 9 - 22 see pages 32-34) were made in the liner. During this latter stage of the testing programme the hole was plugged back twice; to 8077 feet after Test 8, and to 7521 feet after Test 13. After prolonged testing of the interval 7460-7508 feet, in which oil was produced, the cement plug at 7521 feet was drilled out in stages and several tests carried out over the intervals 7580-7620 feet (Tests 17 - 19) and 7830-7860 feet (Tests 20 - 21), on completion of which a 5" Baker type "N" bridge plug was set at 7520 feet. The final tests (Nos. 22 and 23) were exhaustive production tests of the zone 7460-7508 feet, applying a minimum back pressure to the formation.

On 22nd December, 1958, a 7" Baker type "N" bridge plug was set at 7360 feet.

Two deviated holes (Puri 1A and Puri 1B) were then drilled from the original hole.

On 2nd September 1959, a cement plug was placed from 2,200 to 2,000 feet in the original hole (Puri 1) sealing off the deviated hole Puri 1B. The cement was drilled out to 2,070 feet, and a programme of testing of the interval from 1996 to 1760 feet was then carried out. This was accomplished by perforating the 9 5/8" and 13 3/8" casing opposite the zones 1996 - 1980 feet, 1968 - 1950 feet, 1870 - 1850 feet, and 1780 - 1760 feet. Seven drill stem tests were carried out, and the results indicated that no oil was present and that the zones were water-bearing and contained small amounts of gas.

The above testing programme was carried out because oil staining was recorded in the basal 4 feet of Core No. 19 (1975 - 1985 feet) and also because the resistivity curves

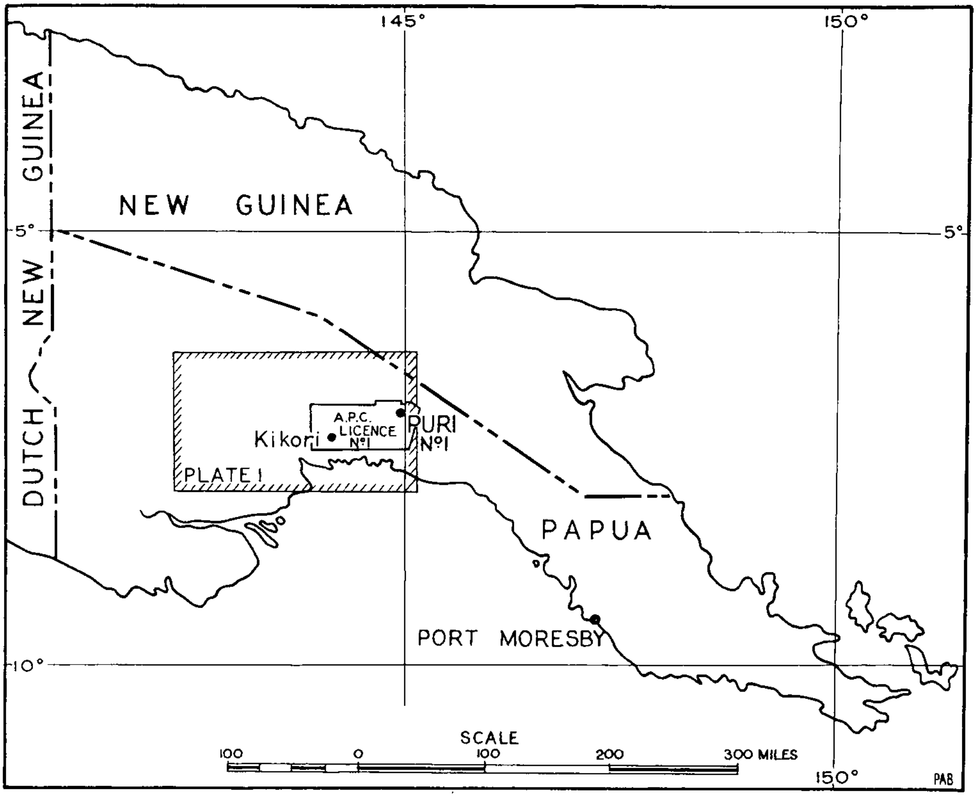


Fig. I Locality Map

indicated that other zones within the 1996-1760 foot interval might have contained oil and/or gas.

On completion of these tests the hole was finally plugged on 16th September 1959. Two cement plugs were placed in the hole: one from 1785 feet to 1620 feet and the other from 200 feet to 50 feet.

PHYSIOGRAPHICAL AND GEOLOGICAL ENVIRONMENT.

The Puri No. 1 well is located at Lat. 7°06'24" South, Long. 144°59'56" East in unpopulated densely forested, high-rainfall, foothill country north of the Era-Purari delta. The drilling equipment, all supplies, and personnel were transported to the area by helicopter service from a transhipment base on the Era River.

The well was sited on the north flank of the Puri anticline about 1,100 feet from the surface crestline. The regional geology of the Puri area is illustrated on Plate 2.

Topography.

The "Muruan" mudstone which crops out on the north and south flanks of the Puri anticline is eroded to form an easterly trending tract of relatively low hilly country about four miles wide bounded on the north by a prominent escarpment of Pliocene sandstone, 1,000-1,400 feet high, and on the south by a less distinct strike ridge of Pliocene sandstone about 600 feet high. Within this tract, a finely textured consequent drainage closely reflects structure; streams, which attain a local base level of 150-200 feet above sea level, flow along mudstone members of the "Muruan" succession leaving sandstone members as strike hills with local relief of 200 to 300 feet. This drainage flows via Puri Creek to the Era River, which rises in Mt Favenc, flows easterly along the northern flank of the Kereru Range (2,000 feet a.s.l.), and thence along the strike of Pliocene sandstones to Woodward's Junction, where, after being joined from the east by the Mena River, it cuts abruptly across a succession of low strike ridges to swampy alluvial flats and the Era-Purari delta.

Summary of Geological History.

The period of most interest, as far as Puri is concerned, is the Tertiary, and the principal features during this time which affected the deposition at Puri were the Aure Trough and the Wana Swell. The Puri well is situated on the east flank of the Wana Swell, close to the Aure Trough..

The Aure Trough is the name given to an elongate area north of Kerema where very thick Tertiary sediments, predominantly clastic, accumulated in a deep trough trending northerly from the coast and swinging north-west in the Middle Purari area. Reasonable exposures and results of drilling show that the Aure Trough was in existence up to the end of the Miocene. During the Pliocene in the Puri area, sandstone and mudstone * were deposited in the much smaller Era-Purari Basin superimposed on the Aure Trough and partly overlapping on the Wana Swell.

---

* There are no known quartz sandstones in post-Jurassic sedimentation in the Aure Trough. In accordance with the operating company's practice, "sandstone" and "sand" are used throughout this report to denote grainsize and not rock composition. All non-calcareous arenaceous sediments encountered in the Puri well are varieties of greywacke. "Mudstone" is used for non-laminate rock dominantly of clay-sized particles (i.e. less than 0.004mm.).

The Wana Swell is the name given to a zone of stability on the west side of the Aure Trough. In general it trends north-west from Wana and persisted through the Tertiary until late in the Miocene.

Stratigraphical Succession.

Pliocene.

The majority of exposures in the Era-Purari area are Pliocene mudstone and sandstone with thin coal beds.

The upper portion of the succession consists of about 700 to 1,000 feet of non-marine cross-bedded ferruginous medium to coarse-grained sandstone, and thin fine-grained well-bedded sandstone with interbedded grey sandy mudstone and carbonaceous mudstone. Occasional thin lignitic coal seams occur in the upper part of the sequence. Underlying these deposits is a succession of thick beds of blue-grey mudstone and siltstone with numerous interbedded coal seams and thin fissile sandstone with a total thickness probably more than 1800 feet. This coal group is underlain by about 3,500 feet of compacted well-bedded fine-grained blue-grey sandstone and sandy mudstone which are locally carbonaceous, thick and thin bands of calcareous sandstone, and intercalated mudstone. In the more silty layers, bands of molluscan remains are a characteristic feature.

The thickness of the Pliocene is of the order of 6000 feet, but local variation and imcomplete sections prevent a closer general estimate.

Miocene.

"Muruan" Stage (upper Miocene): The "Muruan" sediments consist of predominantly dull grey, carbonaceous foraminiferal mudstone interbedded with fine-grained silty, locally calcareous, sandstone. The mudstone is highly incompetent and where disturbed by faulting usually forms a pug zone. The "Muruan" thickens from west to east; in the immediate area of the well it is about 5,800 feet thick.

"Ivorian" Stage (middle Miocene): The "Ivorian" stage, which is conformably below the "Muruan", is represented by a well bedded, very fine-grained grey and light grey marl formation about 500 feet thick which contains abundant Orbulina.

"Taurian" Stage (upper lower Miocene): The "Ivorian" marl grades downwards to fine-grained, thin to massive bedded, usually well jointed argillaceous limestone with a predominantly pelagic foraminiferal fauna and frequently with small nodules of pyrite. Only the uppermost 250 feet of this limestone is exposed on the Puri anticline. Descriptions of the remainder of the formation are based on examination of cores and cuttings from the Puri well, and on exposures in the Kereru Range, 5 miles away. The thinkness is 1150 feet in the Puri well and 1800 feet in the Kereru Range.

The argillaceous content of the limestone varies with depth but when it increases a pelagic fauna predominates. Shoal limestones with algal, echinoid, and bryozoan fragments occur occasionally within this formation.

"Kereruan" Stage (lower lower Miocene): The "Taurian" limestone passes downwards conformably to limestone of "Kereruan" age. The thickness of this limestone varies considerably; 200 feet were recorded in the Puri well whereas 400 feet are present in the Kereru Range. Lithologically, the "Kereruan" limestone consists of well bedded, sometimes massive, grey to cream, dense, medium-grained, detrital, algal and foraminiferal shoal limestone. A marked stratigraphic break occurs at the base.

Eocene.

In the Puri well about 200 feet of Eocene limestone was encountered, and sections up to 150 feet thick have been measured at outcrop in the Kereru Range.

The limestone comprises two main types: (a) an echinoderm calcarenite, typically recrystallized, with sand grains usually along stylolites, and sporadic glauconite, occasionally with bands of calcareous sandstone; and, underlying it, (b) an algal calcarenite, light cream, massive and partly recrystallized.

Cretaceous.

The total thickness of the Cretaceous in the Puri area is unknown; but in the Kereru Range sections of lower Cretaceous siltstone at least 1600 feet thick have been measured.

There is a major disconformity at the base of the Eocene and all of the Upper and most of the Lower Cretaceous is missing. The Lower Cretaceous beds consist of dark grey hard silty mudstone, occasionally sandy, pyritic and slightly micaceous. Spheroidal or sub-spheroidal concretions of dark grey argillaceous limestone are quite common, and grey-green glauconitic argillaceous siltstone members up to 500 feet thick are known. Considerable and rapid lateral variation of lithology occurs; mudstone and shale grade to siltstone over relatively short distances.

Jurassic and older beds are not exposed in the area and were not penetrated in the Puri well.

Structure.

Major stratigraphic breaks occur both above and below the Eocene, but no angular unconformity is apparent in the area.

The major orogeny occurred in late Pliocene time. The Puri structure, situated on the southern margin of a tightly folded and thrust-faulted belt, is an asymmetrical anticline in which the core and north flank have been thrust over the steep faulted southern flank. This mode of deformation may be typical in this structural province.

STRATIGRAPHY.

Summary.

The well spudded in Miocene "Ivorian" marl and followed a normal and expected succession through the "Taurian" limestone, "Kereruan" limestone, and Eocene limestone.

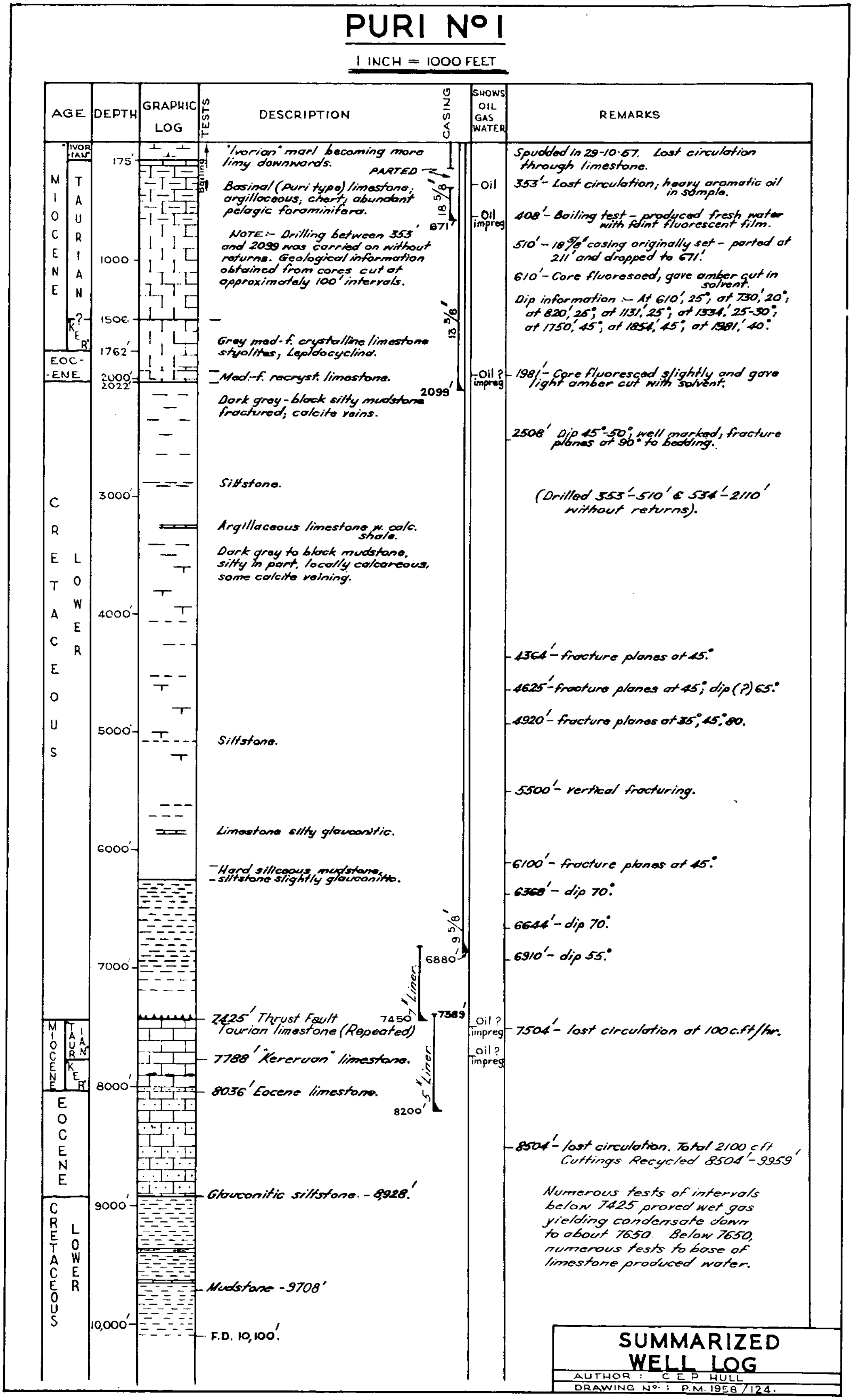

PURI Nº I
1 INCH = 1000 FEET
AGE
DEPTH
GRAPHIC LOG
TESTS
DESCRIPTION
CASING
SHOWS OIL GAS WATER
REMARKS
IVORIAN
MIOCENE
TAURIAN
?
KER
EOCENE
CRETACEOUS
LOWER
MIOCENE
TAURIAN
KER
EOCENE
CRETACEOUS
LOWER
175'
1000
1500
1762'
2000'
2022'
3000'
4000'
5000'
6000'
7000'
8000'
9000'
10,000'
Bailing
"Ivorian" marl becoming more limy downwards.
PARTED
Basinal (Puri type) limestone; argillaceous; chert; abundant pelagic foraminifera.
NOTE:- Drilling between 353' and 2099 was carried on without returns. Geological information obtained from cores cut at approximately 100' intervals.
Grey med-f. crystalline limestone stylolites, Lepidocyclina.
Med.-f. recryst. limestone.
Dark grey-black silty mudstone fractured; calcite veins.
Siltstone.
Argillaceous limestone w. calc. shale.
Dark grey to black mudstone, silty in part, locally calcareous, some calcite veining.
Siltstone.
Limestone silty glauconitic.
Hard siliceous mudstone, siltstone slightly glauconitic.
7425' Thrust Fault Taurian limestone (Repeated)
7788' "Kereruan" limestone.
8036' Eocene limestone.
Glauconitic siltstone. - 8928.'
Mudstone -9708'
F.D. 10,100'.
18 5/8"
871'
13 3/8"
2099'
9 5/8"
6880'
7" Liner
7450'
7589'
5" Liner
8200'
Oil
Oil impreg
Oil ? impreg
Oil ? impreg
oil ? impreg
Spudded in 29-10-57. Lost circulation through limestone.
353' - Lost circulation; heavy aromatic oil in sample.
408' - Boiling test - produced fresh water with faint fluorescent film.
510' - 18 5/8" casing originally set - parted at 211' and dropped to 671'.
610' - Core fluoresced, gave amber cut in solvent.
Dip information :- At 610', 25°; at 730', 20°; at 820', 26°; at 1131', 25°; at 1334', 25-30°; at 1750', 45°; at 1854', 45°; at 1981', 40°.
1981' - Core fluoresced slightly and gave light amber cut with solvent.
2508' Dip 45°-50°; well marked; fracture planes at 90° to bedding.
(Drilled 353'-510' & 534'-2110' without returns).
4364' - fracture planes at 45°.
4625' - fracture planes at 45°; dip (?) 65°.
4920' - fracture planes at 35°, 45°, 80.
5500' - vertical fracturing.
6100' - fracture planes at 45°.
6368' - dip 70°.
6644' - dip 70°.
6910' - dip 55°.
7504' - lost circulation at 100 c.ft/hr.
8504' - lost circulation. Total 2100 c.ft Cuttings Recycled 8504'-9959'
Numerous tests of intervals below 7425 proved wet gas yielding condensate down to about 7650. Below 7650, numerous tests to base of limestone produced water.
SUMMARIZED WELL LOG
AUTHOR : C E P HULL
DRAWING Nº : P.M. 1958 / 124.

Fig. 2

The nature and thickness of the underlying Cretaceous shale was not known, but it was hoped that they could be penetrated by the drill, so that the underlying formations could be tested. However, a major thrust-fault caused repetition of the succession from near the top of the "Taurian" limestone, and drilling was stopped while the well was still in Cretaceous shale with, according to probable thickness, the lowermost Cretaceous and Jurassic beds beyond the capacity of the rig.

Miocene : Surface to 1762 feet.

The well spudded in "Ivorian" marl, a grey marl with abundant pelagic foraminifera, grading to a harder grey marly limestone. The boundary between the "Ivorian" marl and the underlying "Taurian" limestone is transitional, but has, for convenience, been placed at 175 feet. (NOTE: All depths are below Rotary Table). Because of lost circulation, information on the limestone succession was obtained only from cores, and hence the succession cannot be completely documented.

The "Taurian" limestone generally is a grey, marly, fine-grained to dense limestone, with abundant pelagic foraminifera, fractured and veined with calcite, and with rare pyrite; chert nodules occur locally (not observed in cores above 1131 feet). Acid solubility tests indicated that the clay content tended, in general, to decrease with depth.

Core No. 15 at 1518-1529 feet showed a marked change, in lithology and fauna, to a shoal limestone. Shoal limestone does occur in the "Taurian" limestone (e.g., Core No. 2, 610-620 feet) and Core No. 15 has either a lower "Taurian" or "Kereruan" fauna. However, Schlumberger logs suggest a change to a lithology which continues downwards with some consistency, and for this reason the top of the "Kereruan" has been placed at 1506 feet.

The "Kereruan" limestone differs from the "Taurian" limestone in being predominantly a shoal limestone, grey white to brownish white in colour, with a high acid solubility (95%); it is medium to finely crystalline, fossiliferous, and fragmental with occasional chert and stylolitic partings. A rather more argillaceous and dense section occurs near the base, showing a return to a pelagic depositional environment.

Eocene : 1762 to 2022 feet.

The top of the Eocene is placed, on faunal grounds, supported by lithology, between Cores No. 17 and 18; a change of character of the Schlumberger logs at 1762 feet has been taken as the top of the Eocene. Lithologically the Eocene, as recovered in Cores 18 and 19, differed markedly from the overlying "Kereruan" in being a partly recrystallized, silty, detrital, locally glauconitic limestone, varying in colour from light olive grey to brownish grey and white. Frequently the rock consisted largely of a calcite mosaic. Fauna in the upper part is poor, but becomes more plentiful downwards.

The base of the Eocene was placed, purely on Schlumberger log evidence, at 2022 feet.

Cretaceous : 2022 to 7425 feet.

The suggestion below 2022 feet consisted of silty, dark grey mudstone fractured, veined, and slightly calcareous from 3500 to 3900 feet and from 4600 to 5200 feet. Lithological details of the succession are included in the composite well log (Plate 5).

The lack of lithological marker beds and the paucity of diagnostic fauna did not permit any age classification more restricted than Lower Cretaceous.

Only occasional thin beds of dark to medium greenish-grey glauconitic siltstone were recorded above 6259 feet, but below this depth and about 100 feet below a thin bed of very hard siliceous mudstone the glauconitic siltstone became predominant. Below 7060 feet, soft flaky mudstone predominated until at 7425 feet the well passed through a thrust fault and re-entered "Taurian" limestone, at a stratigraphical horizon more than 650 feet below the base of the "Ivorian" marl.

<u>The Succession below the Thrust</u> : 7425 to 10,100 feet.

The "Taurian" limestone and "Kereruan" limestone successions correlated well with the sequence in the upper part of the hole. The top of the "Kereruan" was placed, on lithological grounds, at the top of the shoal limestone at 7788 feet.

The Eocene (top at 8036 feet) for the first 400 feet (drilled thickness) correlated well with the succession first encountered, but after a total drilled thickness of 784 feet some repetition of beds was suspected. This suspicion was supported by faunal and lithological evidence, although conclusive proof is not available.

Below the Eocene there was a succession of dark grey-green glauconitic siltstone, with minor dark grey to black mudstone interbeds below 9700 feet. These black mudstone interbeds contained a typical Lower Cretaceous funa.

Although no positive proof is available the writer feels that this siltstone should be correlated with the siltstone below 6259 feet. Lithologically they are similar and their faunas are identical. Another point of interest is the presence of hard, buff, siliceous mudstone at 6140 feet and traces of a similar bed near total depth. On both occasions drilling speed was severely reduced in this siliceous mudstone. However, in view of the lack of more concrete evidence it is thought unwise to state categorically that both siltstones are the same.

The formation below the Eocene was predominantly a very glauconitic grey-green medium-grained siltstone with rare pyrite. Mudstone was recovered sporadically, but this was regarded either as thin streaks or contamination. The micro-caliper log suggests that thin bands of mudstone do occur, and at 9717 feet a sample taken with a junk basket during a fishing job recovered dark grey to black shale with typical Lower Cretaceous fauna. From that depth to 10,100 feet the siltstone continued with variable amounts of mudstone.

White limestone, similar to the Eocene limestone, was seen in samples from 9355-9389 feet and from 9624-9642 feet. Schlumberger logs and slight increases in drilling speed suggest that the limestone was in situ. This occurrence is further discussed later in this report in connexion with structural interpretation.

In conclusion it should be noted that the following factors have adversely affected the reliability of the lithological log :-

(1) Total loss of circulation from 540 to 2110 feet

(2) Recycled cuttings and sealing agents from 8509 to 9959 feet

(3) Recovery of much limestone and mudstone as a sludge or pug.

(4) Washing out and caving of mudstone because of slow penetration and necessity at times of pulling back.

Emphasis must also be placed on the remarkably contorted nature of the Cretaceous mudstone, particularly above the thrust. The degree of slickensiding was intense, and the extent of fracturing indicates that the beds are, in all probability, a jumbled mass. In view of this no reliance can be placed on the drilled thickness as an indication of stratigraphic thickness, and it is thought that it would be most unwise to incorporate Mesozoic thickness figures from the well in any regional work.

STRUCTURE.

The Puri structure, at first envisaged from surface evidence as a somewhat steeply folded simple anticline, proved on drilling to be thrust-faulted, with several additional minor complications.

Interpretation of the structure is difficult, depending as it does on the interpretation of the regional structure in an area over which there is still considerable controversy, and the information from one well does little more than complicate the detailed picture, although certain general principles are established.

Well Information.

Dips obtained in the Tertiary limestone were more or less as expected from surface evidence, dip measurements ranging from 25^o in the upper part to $40\text{-}45^o$ below 1700 feet. No certain evidence of dip was obtained in the Cretaceous shale, although the indications were that down to 6140 feet dips were probably steep. The shale had obviously been considerably fractured, with calcite veining at the top and very intense slickensiding throughout. Dips in the siltstone, 6140-7425 feet, were clear and ranged from 70 to 55^o.

At 7425 feet the "Taurian" limestone was repeated, giving conclusive evidence of a thrust-fault. Dips in the Tertiary limestones varied from 45 to 70^o. At 8928 feet the well encountered a glauconitic siltstone, immediately underlying the Eocene, and dips in this formation were of the order of 50^o.

Other points of structural interest are :

(a) The drilled thickness of the Eocene, where first encountered, was 260 feet and its estimated true thickness was 192 feet (see 'g' below).

(b) The well encountered Cretaceous shale at 2022 feet immediately below the Eocene. (Direct evidence of this is lacking because of lost circulation, but Core No. 20 (2100-2110 feet) was normal Cretaceous mudstone).

(c) The lack of any stratigraphical or faunal markers within the mudstone succession from 2022 to 6140 feet.

(d) The faunistically barren nature of the siltstone between 6259 and 7425 feet, and the generally poor quality of samples made correlations doubtful.

(e) The obvious thrust-fault at 7425 feet repeating the "Taurian" lime stone.

(f) The correlation, lithologically and palaeontologically, of the "Taurian" and "Kereruan" limestone above and below the thrust.

(g) The drilled thickness of the Eocene below the thrust was 892 feet, and its estimated true thickness was 572 feet (see 'a' above).

(h) The probability of repetition within the Eocene below the thrust.

(i) Immediately below the Eocene at 8929 feet, the well encountered glauconitic siltstone completely different in lithology from the mudstone underlying the Eocene at 2022 feet.

(j) The siltstone continued to total depth with minor intercalations of Cretaceous mudstone. The two dips obtained were of the order of 50°.

(k) The possible presence of Eocene limestone in the siltstone at 9355-9389 feet and 9624-9632 feet.

Interpretation.

The structural section across the Puri anticline (Plate 2) represents the interpretation favoured after consideration of many possible alternatives. It would appear logical to interpret the structure basically as an overthrust anticline, but in detail the following problems must be considered:-

1. The thickness of the Eocene above and below the thrust (estimated as 192 feet above and 572 feet below - true thickness). Very little information is available on the stratigraphy of the Eocene above the thrust but it appears to occur in both shoal and deeper water facies. Dilley suggests that the 260 feet (drilled) of Eocene above the thrust may be the actual thickness (this is supported to a certain extent by the Kereru Range exposure, where the Eocene thickness is of the order of 250-350 feet), and that the greater thickness below the thrust is the result of repetition, due to either folding or faulting. It could be equally arguable that the thickness below the thrust is normal (with alternations of reef-shoal and pelagic limestone) and the variation is attributable to the Cretaceous/Eocene and Eocene/"Kereruan" unconformities.

2. The stratigraphical position of the glauconitic siltstone, and its correlations above and below the thrust. It is felt, although no positive proof is available, that the two occurrences of siltstone are correlatable on lithological grounds, and that therefore the occurrence above the thrust is also Cretaceous shale. But above the thrust the Eocene is underlain by mudstone and the siltstone is not encountered until a depth of 6140 feet, whereas below the thrust the siltstone immediately underlies the Eocene.

Two possible explanations are given, but neither is entirely satisfactory:-

(a) The Eocene above the thrust lies unconformably on Cretaceous mudstone with the siltstone cut out by the fault that forms a disturbed zone at the surface on the south flank of the Puir Anticline. The disadvantage of this is the difficulty of disposing of the Eocene on the downthrown side of the fault on the north flank of the anticline and for practical reasons the idea is not regarded favourably.

(b) The glauconitic siltstone was removed by peneplanation following pre-Tertiary normal faulting. The fault originally haded to the south, with the downthrown side to the north. After peneplanation in late Cretaceous time the Tertiary limestone and overlying formations were deposited, and post-Pliocene folding and thrust-faulting followed. This explanation is favoured and steep dips recorded (LPE, KAC) * in the "Muruan" on the south flank is perhaps evidence in favour of it.

3. <u>The outcrop and possible correlation of the thrust fault intercepted at 7425 feet.</u> This is one of the more controversial issues and depends very greatly on the interpretation of the regional structural picture.

The more important faults in the area are the Era and Kuku faults. Stanley (LPE-1) joined the Kuku fault from the south flank of the Puri structure via Haw Creek to the northern flank of the Kereru anticline. Linton on the other hand (KAC-1) maintains that the Kuku fault dies out between Haia and Pwo Creeks and the inference is that it would therefore be unlikely to have a controlling influence on the Puri anticline, at any rate in the area in which the well was drilled.

The zone of disturbance shown on Linton's map to the south of the Puri structure is presumably an expression on the surface of faulting or sharply folded beds in the "Muruan", but it is uncertain how much importance one can attach to the zone.

The opinion of the writer is that the Era Fault is probably the controlling influence over the Puri structure, with the Kuku Fault, if present at all, a secondary expression of the Era Fault.

4. <u>The direction of dip below the thrust</u> was unknown on the information available from the Puri Well No. 1. However information available from Puri Wells Nos. 1A and 1B has shown the dip direction below the thrust to be to the south, and this has been incorporated into the cross-section.

5. <u>The possible presence of Eocene limestone within the Cretaceous siltstone at 9355-9389 feet and 9624-9632 feet, below the thrust.</u> This may be the result of sinuous folding, but it is felt that as the dips obtained were relatively consistent (45° - 65°) it is more likely to have resulted from contamination by cavings or by fault repetition.

6. <u>The thickness of the siltstone</u> is unknown either above or below the thrust. Samples above the thrust were contaminated by cavings and those below were recycled to eliminate

---

* KAC & LPE refer to unpublished company reports.

circulation troubles, and consequently lithological logging was probably inaccurate. It is felt, however, that the lower part of the siltstone above the thrust was more argillaceous than that below, but this is probably only localized facies variation.

7. Neither can a figure be given for the thickness of the balance of the Mesozoic sediments. The extremely contorted and jumbled mass of mudstone below the Eocene (2022-6140 feet) may well give little or no indication of its true thickness, and drilling ceased before this formation was penetrated below the thrust-fault.

No adequate information is available which can really be regarded as having a direct bearing on the possible thickness of Mesozoic sediments at Puri, and at this stage it is felt that any estimate of the depth to basement or possible basement configuration would be pure conjecture.

It is perhaps of interest to note that Bliaux (Memo. F238/4114 dated 6/11/1957), in commenting on the Puri-Mena Refraction Survey, states ".....The only other seismic evidence is provided by Arc 16, the northern part of which crosses the Puri axis west of the Puri culmination. Two horizons are recorded ..... the interval between the two refractors is most probably of the order of 6000' to 8000' and they are tentatively identified as the ["Taurian"] limestone and basement". In the light of present knowledge it would appear that the lower of the two horizons may well be the "Taurian" limestone below the thrust, and the depths are in general agreement with this.

PALAEONTOLOGICAL EXAMINATION OF WELL SAMPLES.

TERTIARY FAUNAS AND STRATIGRAPHY.

Middle Miocene ("Ivorian") : Surface to c.175 feet.

Marl of the lower Orbulina subzone rich in pelagic foraminifera is present at about 175 feet, the passage to the "Taurian" limestone below being gradual. Pelagic foraminifera make up the bulk of the fauna, with abundant Orbulina universal (D' Orbigny) Globorotalia menardii (D' Orbigny,) and Globigerinoides triloba (Reuss). Several other species are only a little less common, including Globoquadrina altispira (Cushman Jarvis).

Laticarinina pauperata (Parker Jones), a distinctive member of the lower Orbulina subzone benthonic assemblage, is present.

Lower Miocene ("Taurian") : 175-1526/1633 feet.

Knowledge of the subsurface limestone. section is dependent upon nineteen cores (some of which however yielded little or no recovery); cuttings were returned over very limited intervals only, as a result of repeated circulation losses.

The "Taurian" limestone, as far as can be judged from thin-section examination, differs little in its pelagic foraminiferal assemblage from the "Ivorian" marl of the Orbulina zone. The boundary (despite its transitional character) between the "Ivorian" marl and the "Taurian" limestone has been adopted in previous work on surface samples from the same area as the "Taurian"-"Ivorian" boundary, and for convenience it is proposed to continue this rather artificial classification.

Core 1, 379 feet, is regarded as typical of the uppermost part of the "Taurian" limestone, a fine-grained limestone with abundant large pelagic foraminifera in which Orbulina universa (D' Orbigny), Globorotalia menardii (D' Orbigny), Globoquadrina altispira (Cushman Jarvis) and Globigerinoides triloba (Reuss) are easily recognised. Benthonic foraminifera are almost absent, a large Spiroloculina or Opthalmidium being the only representatives in three random thin sections of average size.

Core 2, 611 feet, is representative of the occasional reef-shoal intercalations which characterize the "Taurian" limestone. Larger foraminifera are common, including common Amphistegina and frequent small Lepidocyclina. Miogypsina is probably absent. Acervulina is locally prominent. Algal, echinoid, and bryozoan fragments, occasional small rotalids and rare Orbulina and other pelagic foraminifera make up the remainder of the assemblage.

Cores between 611 feet and c.1526 feet (2-15 inclusive) are all representative of the pelagic limestone facies, but there is a major faunal discontinuity within this section at about 900 feet, i.e. between Cores 8 and 10. The upper group differs little in fauna and facies from that described under Core 1; the lower group is characterized generally by much smaller pelagic foraminifera, although benthonic forms remain almost completely absent. This discontinuity is very probably facies-controlled, but it may have local correlative value.

Not quite coincident with this change is the downward disappearance of Orbulina, which was not definitely identified below 1140 feet. Globoquadrina altispira (Cushman Jarvis) and Globorotalia menardii (D' Orbigny) were not recognised definietly below the 900 foot level.

Shoal limestones reappear in Core 15, 1526 feet, with a larger foraminiferal assemblage including abundant Nephrolepidina and rare Miogypsina and Miogypsinoides. Spiroclypeus was doubtfully identified, the fragment recorded being either Spiroclypeus or Heterostegina. This level is therefore dated as Lower "Taurian" or "Kereruan".

Lower Miocene ("Kereruan) : 1526/1633-1762/1856 feet.

Core 16, 1633-1646 feet, was taken in reef-shoal limestone and found to contain a diagnostic "Kereruan" assemblage including abundant Eulepidina and Heterostegina borneensis (van der Vlerk). A single specimen of Borelis pygmaea (Hanzawa), which appears to be a characteristic "Kereruan"-Oligocene form in Papua, was also recorded.

Core 17, 1747 feet, shows a return to pelagic limestone facies, the dominant forms present being abundant small Globigerina and common to abundant small Gumbelina. None of the pelagic foraminifera is diagnostic and the range and status of Gumbelina is in some doubt. Recent work appears to relegate Gumbelina to the synonymy of several different genera, the ranges of which are probably not well authenticated as yet. Cushman's range for Gumbelina -- Cretaceous to Oligocene -- cannot therefore be cited as evidence for age without much qualification. It is possible that the interval represented by Core 17 is of Oligocene age, but it is nevertheless grouped conveniently with the "Kereruan".

Eocene : 1762/1856-2022 feet.

Core 18, 1856-1862, differs strikingly in microlithology from the cores above, being a very fine-grained detrital rock, partly recrystallized and composed largely of angular grains of calcite. Fossils are rare and comprise small nondescript rotalids, bolivinids, and textularids. There is therefore no direct palaeontological evidence of age.

The upper part of Core 19, 1977-1983 feet, closely resembles Core 18 in microlithology and fauna. The lower part of the core is rather coarser in grain and more fossiliferous. It contains occasional Discocyclina and Eorupertia?, and small fragments of nummulitids, rotalids, bolivinids, texturalids and very rare Globorotalia and Globigerina are also present. Algal fragments are common, including rare fragments of Distichoplax biserialis (Dietrich). The presence of Distichoplax would suggest, if definitely in situ, Palaeocene, but records of this form in Papua are anomalous; Eorupertia on the other hand is characteristic of the younger Eocene. There is insufficient unequivocal evidence to justify a closer estimate of age for these beds than Eocene.

The junction of the limestone with the underlying siltstone and mudstone of the Lower Cretaceous is placed at 2022 feet on the electric log evidence.

MESOZOIC FAUNAS AND STRATIGRAPHY.

Faunas from the Mesozoic are disappointing. The succession drilled above the thrust consists of monotonous mudstone with variation only in the degree of siltiness. Dips below about 6000 feet are of the order of 70^o and the formation is generally much slickensided and calcite-veined.

The first core (No. 20, 2107-2109 feet) in the Mesozoic mudstone yielded no fossils in washings, although rare tiny "globigerinid" forms were noted in thin sections.

Between 2212 feet and 3328 feet, washing of cuttings yielded only poorly preserved and rare arenaceous foraminifera; at or just below 4100 feet Eoguttulina sp.2, Gaudryina sp.3, Radiolaria Form Genus 2, Verneuilina sp.2, and Ammobaculites sp.7 were recorded -- an assemblage already recorded (KAC) from the Cretaceous shale of the Kereru Range and established by evidence from ammonites and belemnites as of Lower Cretaceous age. At 4721-4725 feet abundant Eoguttulina sp.2, Haplophragmoides, and Lenticulina were recorded from cuttings, and a similar fauna was obtained from Core 25, 4921 feet.

Core 29, 5788-5794 feet, yielded a fairly rich fauna in which arenaceous foraminifera are dominant, the most significant species being Gaudryina sp.3 and a single specimen of Tritaxia. There appears to be no doubt therefore that Cretaceous continues to this level.

Below this all cores and most samples of cuttings to a depth of 7156 feet proved unfossiliferous and no samples yielded significant or datable assemblages.

At 7156-7160 feet a small assemblage of mostly arenaceous foraminifera was recorded, and Core 36, 7217-7227 feet, yielded a very good fauna of arenaceous foraminifera from a portion which broke down very readily. The latter assemblage included common Bathysiphon and Haplophragmoides, together with less common Ammobaculites, Ammodiscus, Dentalina, Haplopragmium, Lenticulina, and Saccammina. In addition, the presence of several specimens of Gaudryina sp.3, which is characteristic of certain levels in the Cretaceous shale and was also recorded from definite Lower Cretaceous higher in the well, strongly suggests the continuance of Lower Cretaceous (or at most transitional uppermost Jurassic) to this depth.

At 7425 feet the well re-entered "Taurian" limestone.

CORRELATION OF THE LOWER AND UPPER LIMESTONES.

The limestone of Core 37, 7469 feet, is much affected by minor faulting or slip, by calcite-veining and replacement and by slickensiding. The pelagic fauna is scarcely affected by this and is clearly recognisable as representing the upper part of the "Taurian" with an assemblage of *Orbulina*, *Globorotalia menardii* (D' Orbigny), *Globoquadrina altispira* (Cushman Jarvis) and other globigerinid and globorotalid forms.

The equivalent level in the upper section of the "Taurian" limestone would be between about 650 feet and 900 feet, i.e., below the shoal limestone of Core 2, and above the change to a small globigerinid assemblage without *Globorotalia menardii* and *Globoquadrina altispira*.

No equivalent of the "Taurian" limestone section without *Orbulina* was seen below below the thrust: basinal limestones with *Orbulina* were recognised in cores to the top of the "Kereruan" at about 7812 feet. The upper part of the "Kereruan" below the thrust is again in shoal limestone facies with *Eulepidina*. Lower in the sequence however there is a return to basinal conditions with finer-grained limestones containing *Globigerina* and *Gumbelina* -- a clear repetition of the "Kereruan" sequence above the thrust.

The Eocene was penetrated much as expected at about 8036 feet, in microlithology identical with Core 18 above the thrust. The Eocene is faunally non-diagnostic at this level, but *Lacazina* appears again at 8155 feet in confirmation.

At 8444 feet algal shoal limestone with *Distichoplax* was recorded, thus indicating an exact repetition of the faunal-microlithological sequence of the Eocene above the thrust. At this point a re-entry into Cretaceous shale was considered imminent, but further drilling indicated the re-appearance of basinal Eocene limestones followed again by algal shoal limestones with *Distichoplax*. It is evident therefore that there is some repetition of the Eocene, which accounts at least in part for the considerably increased thickness.

Cretaceous was eventually re-entered at about 8928 feet in grey-green unfossiliferous glauconitic siltstone, and continued thus, with slight variations in amount of argillaceous matter only, to total depth. A globe basket sample at 9716-9717 feet yielded a well developed Lower Cretaceous microfauna from black mudstone and the balance of evidence suggests that the Cretaceous below the thrust is representative of that part of the sequence below c.6259 feet in the section above the thrust.

HYDROCARBON SHOWS AND CIRCULATION LOSSES.

Shows.

Depth 353 feet. A trace of heavy aromatic oil was reported in the samples and circulation was lost shortly afterwards. The hole was tested by bailing and water with a very faint skim of oil was produced.

Depth 610 feet. The top 2 feet of Core No. 2, 610-620 feet, gave pronounced fluorescence, good amber cut with cold solvent, and emitted a sweet aromatic odour when freshly broken. In appearance the rock was a tight limestone, and the show is regarded as an oil impregnation, similar to many visible on the surface, without possibility of production.

Depth 1981-1985 feet. The basal part of Core No. 19 gave strong fluorescence and good amber cut with cold solvent, and gave off an aromatic odour when freshly broken. Some vuggy porosity was observed in this Eocene shoal limestone.

Depth 7475-7504 feet. Traces of brown oil-stained calcite were observed in the samples and good bluish-white fluorescence obtained. Samples gave an amber cut with cold solvent. Normal precautions were taken against contamination. Circulation was lost at 7504 feet.

Depth 7750-8758 feet. Samples gave a positive cut in cold solvent, and a core was cut immediately, but no trace of hydrocarbons observed. Side-wall cores were cut over the interval with no trace of fluorescence observed from somewhat poor recovery. This occurrence is regarded as being either due to contamination(possibly from minute specks of block-line grease) or an insignificant amount of impregnated limestone.

Occasional other samples gave positive cut with cold solvent, but in each case significant amounts of rig grease were observed.

At no time did the well show any activity whatsoever before testing, even when drilling with water, and no returns before the setting of the 13 3/8" casing.

Circulation Losses

Depth (feet)	Remarks
43-347	Slight losses, total 907 cu.ft. Fractured limestone.
347-353	Complete loss, total 1527 cu.ft., associated with oil smell and bitumen.
353-510	Drilled without circulation.
512-534	Continuous small losses, 12 cu.ft./hour.
534-547	Returns diminished to zero.
547-2110	Drilled without circulation.
7504	Lost 160 cu.ft. at 120 cu.ft./hour. Fractured limestone.
8504	Complete loss, total 2615 cu.ft. Fractured limestone.
8592-8604	Lost 102 cu.ft., at 10-25 cu.ft./hour.
8674-8685	Lost 60 cu.ft. at 10-25 cu.ft./hour.

Depth (feet)	Remarks
8824	Complete loss, total 2800 cu.ft.
8886-8907	Lost 815 cu.ft. at 15-22 cu.ft./hour.
9011	Lost 160 cu.ft. at 60 cu.ft./hour.
9436	Lost 200 cu.ft. at 400 cu.ft./hour.
9662	Lost 400 cu.ft.

The losses at 7504 feet and 8504 feet were probably through fractures in the limestone on bottom.

The losses below 8504 feet, with the probable exception of those at 8824-8889 feet and possibly at 9662 feet were attributed to the breaking down of seals obtained higher in the hole.

SCHLUMBERGER OPERATIONS.

Details of Logs *

No.	Type of Log	Interval Logged	Date
292	Electrical	668-2099	12-1-58
293	Section Gauge	211-1254	12-1-58
294	Laterolog	668-2073	13-1-58
295	Temperature	Surface -1869	17-1-58
309	Electrical	2098-6930	2-5-58
310	Micro-caliper	2098-6901	2-5-58
311	Laterolog	2098-6906	3-5-58
312	Neutron	668-2097	4-5-58
313	Temperature	Surface -6357	11-5-58
320	Electrical	6882-9145	7-7-58
327	Electrical	9045-10084	8-8-58
328	Gamma ray-Neutron	7350-9000	8-8-58
329	Micro-Caliper	6882-10081	8-8-58
330	Laterolog	6882-10081	8-8-58
332	Section Gauge	6884-7420	6-9-58
335	Temperature	6550-7264	9-9-58
336	Temperature	7000-7733	29-9-58
	Photo-Inclinometer	2430-6885	4-5-58

The Schlumberger logs indicated certain changes in character in the Tertiary limestone above the thrust, which in conjunction with palaeontological evidence, have been taken as the tops of the "Kereruan" limestone and of the Eocene.

---

* Copies of these logs are available for perusal at the Bureau of Mineral Resouces, Canberra.

The laterolog and gamma ray-neutron log were particularly useful in showing changes of formation. On the other hand, because of the salt mud, over some intervals, the electric log, particularly the S.P. curve, is only of value for purposes of broad correlation.

The micro-caliper log confirmed the impression obtained while drilling that the mudstone section was washing out and carving to a considerable extent, and also indicated very considerable overhole in the upper part of the limestone below 7425 feet.

The side-wall cores were generally unsuccessful. At the first attempt a combination of medium hard and hard formation bullets were run with 10 grain charges. Neither type of bullet penetrated the formation, and the gun, on being pulled out for electrical repair, was reloaded with hard formation bullets and 12 grain charges, and two runs were made.

From neither interval shot was recovery more than a small chip bearing little resemblance to a true core. The material recovered was in nearly every instance mixtures of ground-up limestone fragments which afforded little or no information either lithologically or palaeontologically.

The photo-inclinometer survey was run over the interval 2430-6885 feet in order to assess the potential difficulties in running the 9 5/8" casing, in view of the somewhat large deviation figures obtained while drilling. The survey showed that the hole ran in a general NW-NE direction with no particularly difficult places. The casing was run to the desired depth.

Side Wall Cores.

Three runs were made with the sidwell coring gun over the intervals 7730 feet - 7760 feet and 8040 feet - 8060 feet, but recovery was poor and only nine cores were considered to be of any value. There were at 7753 ft., 8044 ft., 8047 ft., 8049 ft., 8051 ft., 8053 ft., 8057 ft., 8059 ft., and 8060 ft.

Log Interpretation.

The following comments were received from the British Petroleum Company Research Station at Sunbury, England :-

"We have examined the logs from Puri Well No. 1 covering the depth interval 6882 - 10,008', and we have the following comments to make.

The broad interpretation is as follows :-

6150 - 7118'	Impermeable, low porosity siltstone (less than 5%) which is water bearing.
7118 - 7425'	Shale
7425 - 8350'	Hydrocarbon bearing zone. Porosity ranges from 4% - 11%. The maximum water content is 30% and the minimum hydrocarbon content is 70%.

8350 - 8490'	The hydrocarbon/water transition zone where the water content increases from 30% at the top to 100% at the bottom.
8490 - 8510'	High porosity (11 - 12%), low permeability limestone with 100% water content. There are no indications of shale on the gamma ray log.
8510 - 8928'	Hydrocarbon/water zone. Porosities range from 5 to 11% (average 8%) with water contents varying between 40% and 70%.

The detailed analysis of the broad interval 7425 - 8510' suggests that the following zones should be tested in order of merit.

(1)	7775 - 7940'	Clean limestone interval of porosity 4 - 5% and on average hydrocarbon content of 70% of the pore space.
(2)	7425 - 7510'	Similar interval to number (1) but porosities are in the range 6 - 9%. (The interval 7510 - 7770' between zones (1) and (2) tends to be shaly but still has a good hydrocarbon content).
(3)	8200 - 8350'	This limestone interval has no shaly indications and porosities vary between 6 and 7% and the hydrocarbon content averages 70%. Several high resistivity bands, which are shown to be porous by the neutron log, are probably dolomite or gypsum and not porous limestone.
(4)	8025 - 8190'	The porosity of this limestone interval is very variable (4 - 11%) and there are some shale bands. The interval is hydrocarbon bearing - approximately 70% of the pore space, but the porosity estimates are subject to considerable error due to the presence of shale.
(5)	8350 - 8510'	Hydrocarbon/water transition zone which has a porosity of 10 - 12% and is virtually free of shale. A test of this zone would confirm that this is really a transition zone."

OIL AND GAS POSSIBILITIES.

The absence of any large scale show of hydrocarbons in the Tertiary limestones was discouraging in view of the numerous oil and gas indications reported over the surface at Puri, but the discovery that the anticline was thrust-faulted placed the structure in a new light from the point of view of possible production.

It is apparent that the fracturing visible on the surface affects the limestone for some considerable depth, possibly being sufficient to give indirect connexion to surface even from the Eocene. This has always been a somewhat controversial point in reports and discussions on Puri. Some authors suggested that the limestones at a relatively shallow depth would be sufficiently impervious to form a seal over the lower, and possibly more porous, horizons; others maintained that the fracturing and jointing was sufficient for any accumulation of oil or gas in the limestone to migrate to the surface and that the seeps were residual.

In view of the fact that the Tertiary limestones above the thrust were drilled mainly with water only in the hole, it is unlikely that any high-pressure accumulations exist, as no indications of activity by the well were ever observed. The complete lack of circulation during this section of the hole did not assist in the evaluation of reservoir possibilities, but only rarely were even medium rates of penetration obtained (and then only over short intervals) and cores were cut at sufficiently frequent intervals to reduce the possibility of drilling blind through a major zone of hydrocarbons.

The mudstone/siltstone succession was essentially tight (but fractured in part, particularly in the upper section) and no signs of porosity were observed with the exception of rare very thin stringers of coarse siltstone which appeared in samples to be somewhat loosely cemented.

The Tertiary limestones below the thrust were observed with care in view of the obvious fault trap present. However few clear indications of hydrocarbons were seen, although cores were taken at frequent intervals, occasionally with little real justification.

The information from one well on a complex structure is frequently misleading and it would be unwise to attempt any detailed evaluation of this structure on the information available. The results of the well would seem to indicate that perhaps the sandstones within the "Muruan" mudstone formation on the downthrown side of the thrust might make an attractive target, but it is emphasised that any second hole at Puri would have to be regarded primarily as a structure test hole: the possibilities of finding oil or gas in commercial quantities would be highly conjectural.

The Puri seepages and impregnations, about which much has been written in the past (LPA, LPE, KAC) are numerous, and one gas blow on Seppi Creek is of considerable size. It would appear that in all probability the seepages are connected with the Tertiary limestones or calcareous sandstones in the "Muruan" mudstone sequence below the fault, partial connexion being obtained along the fault plane to the badly fractured and jointed limestones above the thrust, with perhaps localized partial trapping.

It is also considered possible that the Cretacous shale has been sufficiently fractured to permit some passage of oil and gas. However, without further information on structure at depth, any detailed discussion of the seepages can be no more than theoretical.

LIST OF CORES.

Core No.	Interval	Recovery %	Lithology	Dip (Degrees) Uncorrected.
1	378-386	-	Limestone	25
2	610-620	40	"	25
3	701-711	30	"	N.A.
4	711-721	20	"	N.A.
5	721-723	Nil	-	-
6	723-738	50	Limestone	20
7	808-818	Nil	-	-
8	818-828	20	Limestone	25
9	828-837	25	"	25
10	925-930	10	"	N.A.
11	1023-1028	40	"	"
12	1131-1146	40	"	25
13	1225-1240	30	"	N.A.
14	1334-1350	50	"	25-30
15	1518-1529	100	"	N.A.
16	1630-1647	100	"	"
17	1743-1748	90	"	45
18	1855-1865	65	"	45
19	1975-1985	100	"	40
20	2100-2110	75	Mudstone	N.A.
21	2508-2515	50	"	40-45
22	4364-4367	100	"	N.A.
23	4617-4625	90	"	"
24	4625-4629	100	"	?65
25	4920-4930	100	"	N.A.
26	5212-5222	90	"	"
27	5490-5500	Nil	-	-
28	5500-5507	142	Mudstone	N.A.
29	5788-5794	30	"	"
30	5794-5802	38	"	"
31	6100-6109	27	"	"
32	6109-6115	50	"	"
33	6368-6380	100	Siltstone	70
34	6644-6656	100	"	70
35	6907-6917	100	Mudstone	55-60
36	7217-7229	100	"	55
37	7459-7471	100	Limestone	45
38	7518-7529	100	"	45
39	7662-7674	100	Limestone	70
40	7758-7768	100	"	50
41	8067-8079	88	Limestone	50
42	8378-8838	100	"	60
43	8504-8509	100	"	45
44	8782-8788	92	Limestone	65
45	8948-8958	100	Siltstone	50
46	9246-9256	100	"	54
47	9408-9418	100	"	50

Schlumberger side-wall cores were taken over the following intervals: 7730-7760', 8040-8060'.

Recovery was poor, very little solid formation being obtained; the bulk of recovery was ground-up pug.

CORE ANALYSES.

Suitable cores were analysed by standard methods and the results are given below:-

Core No.	Depth feet	Oil % Site	Water %	Porosity %	Permeability mdcs	NaCl ppm	Lithology
1	380	Trace	6.1	4.3	Nil	240	Limestone
2	611	2.21	10.4	17.0	0.4	240	"
6	726			3.5	Nil	Nil	"
12	1140	Nil	0.75	2.4	Nil	Nil	"
14	1336	Nil	1.3	2.3	Nil	Nil	"
15	1526	Nil	2.7	3.8	0.05	Nil	"
16	1640	Nil	7.4	8.1	Nil	750	"
17	1747	Nil	0.8	1.9	Nil	1500	"
18	1856			5.6	Nil		"
19	1984			7.2	0.3		"
23	4620			5.0	Nil		Mudstone
25	4924			3.0	Nil		"
26	5220			4.9	Nil		"
28	5503			3.2	Nil		"
35	6911			3.1	Nil		Siltstone
36	7221			5.9	Nil		"
37	7463	Trace	0.5	7.7	Nil		Limestone
38	7518	Nil	1.6	2.6	Nil		"
39	7670			3.3	Nil		"
40H	7758			4.9	0.2		"
40V	7758			5.3	Nil		"
41	8074	Nil	1.8			36000	"
42	8382	Nil	1.8				"
43	8953	Nil		1.4	Nil		Siltstone

FORMATION LOG

Depth	Description *
"Ivorian" Marl	
0-175	Grey marl with abundant pelagic foraminifera and rare pyrite, grades downwards to a grey marly limestone.
"Taurian" Limestone	
175-353	Grey marly limestone with abundant pelagic foraminifera and rare pyrite.
353-378	Lost circulation -- no samples.
378-386	Limestone, grey, argillaceous, dip 25°.
386-510	Lost circulation -- no samples.
510-534	Grey-white slightly marly limestone, somewhat friable in part, considerable calcite.
534-610	Lost circulation -- no samples.
610-620	Limestone, white to cream and grey, marly in part, dip 25°, upper section impregnated with aromatic oil (shoal limestone).
620-701	Lost circulation -- no samples.
701-738	Limestone, grey brown, very finely crystalline to dense, marly, occasional small vugs infilled with calcite, abundant _Globigerina_, occasional shale streaks, open fracturing, bedding dip 20°.
738-818	Lost circulation -- no samples.
818-837	Limestone, grey, very finely crystalline to dense, hard, slightly argillaceous, fractured, dip 25°.
837-925	Lost circulation -- no samples.
925-930	Limestone, grey and grey brown, finely crystalline to dense, slightly argillaceous, traces of pyrite.
930-1023	Lost circulation -- no samples.
1023-1028	Limestone, grey brown, dense, slightly argillaceous.
1028-1131	Lost circulation -- no samples.
1131-1146	Limestone grey, banded, slightly argillaceous, occasional chert nodules, rare pyrite, bedding somewhat jumbled suggesting slumping, abundant _Globigerina_.

---

* Detailed lithological descriptions are available at the Bureau of Mineral Resources, Canberra.

Depth	Description
1146-1225	Lost circulation -- no samples.
1225-1240	Limestone, grey, dense, argillaceous, fractured, occasional brown chert nodules, globigerinal.
1240-1334	Lost circulation -- no samples.
1334-1350	Limestone, very finely crystalline to dense, light grey to brownish grey, slightly pyritic, fractured.
1350-1506	Lost circulation -- no samples.
"Kereruan" Limestone (Electric Log Pick)	
1506-1518	Lost circulation -- no samples.
1518-1529	Limestone, grey-white to brownish white, medium to fine crystalline matrix,fragmental, fossiliferous, occasional chert (shoal limestone).
1529-1630	Lost circulation -- no samples.
1630-1647	Limestone, grey-brown to whitish grey, medium to coarsely crystalline, fossiliferous, fragmental (shoal limestone).
1647-1743	Lost circulation -- no samples.
1743-1748	Limestone,finely crystalline to dense, brownish grey, shaly partings, globigerinal (pelagic limestone).
1748-1762	Lost circulation -- no samples.
Eocene (Electric Log Pick)	
1762-1855	Lost circulation -- no samples.
1855-1865	Limestone, silty, light olive grey, finely crystalline, partially recrystallized, calcitic, stylolitic, matrix largely of angular calcite grains forming mosaic.
1865-1975	Lost circulation -- no samples.
1975-1985	Limestone, light olive grey to light brownish grey, finely crystalline, partially recrystallized, bedding dip 40°,occasional stylolites, rare glauconite, basal 4' medium crystalline algal, and with *Distichoplax* fragments. Traces of oil staining were observed.
1985-2022	Lost circulation -- no samples.
Cretaceous (Electric Log Pick)	
2022-2100	Lost circulation -- no samples.
2100-2296	Mudstone, hard silty, very dark grey, very badly veined with calcite at top, pyritic, dip not ascertainable, occasional thin bands of siltstone, soft argillaceous creamy grey or hard, dark grey. Insensible gradation from silty mudstone to argillaceous siltstone occurs and a thin (1') stringer of very fine to silty tight grey sandstone was observed at 2296'.

Depth	Description
2296-2398	Mudstone dark grey, somewhat soft and shaly (much recovered as a sludge), with rare inclusions of pyrite, locally slightly silty, stringers of soft orange mudstone at 2378' and 2390'.
2398-2895	Mudstone, dark grey, silty in part, fractured, calcite veining, stringers of dark and medium grey argillaceous siltstone. A thin band of speckled medium grey calcareous siltstone at 2711' and at 2764' a very thin bed of soft earthy orange mudstone. Rare fragments of dense buff limestone were seen, probably occurring as inclusions in the mudstones.
2895-2908	Siltstone, glauconitic, grey and light grey-green, black-speckled, very slightly calcareous argillaceous matrix.
2908-3534	Mudstone, dark grey, silty in part, rare stringers or inclusions of dense buff limestone, calcite veining, with marked fracture zone 3478-3494'.
3534-3853	Mudstone, dark grey with slight brownish tinge, slightly calcareous, calcite veining, slightly silty in part, considerably fractured.
3853-3992	Mudstone, dark grey, slightly calcareous and silty in part, traces calcite veining, tendency for cuttings to be recovered as sludge.
3992-4006	Mudstone, dark grey, silty, glauconitic, grades to argillaceous glauconitic siltstone locally.
4006-4605	Mudstone, dark grey locally with brownish tinge, very slightly calcareous in part, occasional heavy calcite veining, scattered flakes of biotite. A thin (1') stringer of brown limey siltstone occurred at 4064' and a thin bed of partly decomposed red and yellow quartz grains at 4300'.
4605-5064	Mudstone, flaky, dark grey, locally slightly calcareous, fractured, micaceous.
5064-5092	Siltstone, glauconitic, slightly calcareous, grey, argillaceous, grades to glauconitic silty mudstone.
5092-5564	Mudstone, dark grey locally grey brown, very slightly calcareous in upper part, scattered traces of glauconite, badly fractured and veined, stringers of light grey glauconitic mudstone at 5371' and 5445'.
5564-6139	Mudstone, generally flaky, locally slight silty, dark grey, fractured in part, with rare stringers of soft orange mudstone and grey-green glauconitic siltsone.
6139-6155	Mudstone, grey and greyish brown, locally dark grey, siliceous, hard, with calcite hair veining.
6155-6259	Mudstone, silty, grey and light grey with thin band grey green glauconitic siltstone at 6207'.
6259-7060	Siltstone, dark grey-green, glauconitic, with thin interbeds of dark grey mudstone. (The samples over this interval are poor and the base of the siltstone is in doubt. Below 7060' the mudstone definitely predominates).

7060-7425	Mudstone, dark grey, soft, flaky, locally micaceous, occasionally silty, fractured.

"Taurian" Limestone (Repeated)

7425-7788	Limestone, white to brownish white, very fine crystalline to dense, locally silty, passes rapidly to greyish brown marly dense globigerinal limestone, badly fractured in the upper part. Much of the detail of lithology lost through samples being recovered as a chalky pug. The rock apart from fracturing appeared to be tight.

"Kereruan" Limestone (Repeated)

7788-7868	Limestone, light brown and buff to cream,finely crystalline to dense fragmental,fossiliferous shoal type.
7868-7987	Limestone, light brown and brown to cream, finely crystalline to dense, slightly argillaceous, locally speckled with glauconite, thin band of chert at 7886'.
7987-8036	Limestone, finely sandy to silty, glauconitic, occasionally micro-pyritic, finely crystalline, detrital, fragmental, shoal type.

Eocene (Repeated)

8036-8106	Limestone, medium to finely crystalline, buff to cream and white, recrystallized in part, much of samples recovered as chalky pug.
8106-8208	Limestone, sandy, glauconitic, grey white to buff, dense to finely crystalline, locally recrystallized.
8208-8288	Samples recovered mainly as white chalky pug, suggesting a dense platey recrystallized limestone with occasional glauconitic sandy beds.
8288-8509	Limestone, white to cream and buff, partially recrystallized, occasional sandy glauconite intercalations, locally fractured, stylolitic partings, some calcite veining.
8509-8782	Very poor recovery due to recycling of cuttings and sealing agents. Small amount of limestone chips obtained suggests formation similar to 8288-8509'.
8782-8928	Limestone, sandy and glauconitic, recrystallized, much recovered as chalky pug, possibly becoming less sandy towards base (recycled cuttings).

Cretaceous

8928-9160	Siltstone, grey green, highly glauconitic, hard, dense, the rock consisting of fine subangular quartz grains in a siliceous matrix with abundant glauconite.
9160-9230	Samples from recycled cutting suggest presence of thin interbedded mudstones in siltstone.

Depth	Description
9230-9355	Siltstone, dark grey-green, glauconitic.
9624-9632	Limestone, white, recrystallized algal (typical* Eocene). Position in situ confirmed by Schlumberger.
9355-9389	Samples contained up to 50% white Eocene* limestone, recrystallized. Schlumberger logs confirmed the presence of limestone in situ.
9389-9624	Siltstone, dark grey-green, glauconitic.
9624-9632	Limestone, white, recrystallized, algal, (typical Eocene**).
9632-9708	Siltstone, dark grey-green, glauconitic.
9708-10100	Siltstone, dark grey-green, glauconitic, with interbedded mudstone.

DRILLING FLUID CONTROL.

Surface - 510 feet.

The well was spudded-in using a high pH mud; the marls encountered in the top 175 feet of hole dispersed readily in the mud, necessitating constant additions of water to keep the weight, viscosity, and gels at reasonable values. Circulation was completely lost at 353 feet, and all efforts to seal off the formation with sawdust, cotton seed hulls, and celloflake wee unsuccessful. Drilling and coring were therefore continued without returns, batches of viscous native clay mud loaded with sealing agents being pumped to the hole periodically to clear away the cuttings from the bottom of the hole. Hole condition remained good over this section and no difficulty was encountered in running the 18-5/8" casing.

510 feet - 2110 feet.

The 18-5/8" casing shoe was drilled out using a bentonite - local clay mud heavily loaded with lost circulation material, but at 534 feet a complete loss occurred and although this was partly sealed the returns diminished to zero at 547 feet. The loss zones could not be sealed off, so drilling was continued throughout this section of the hole down to 2110 feet without returns, using water interspersed with batches of local clay mud. When a change of formation had been confirmed by a core taken over the interval 2100 feet - 2110 feet it was decided to run the 13-3/8" casing. Before the casing was run further attempts were made to seal off the loss zones using sealing agents, formaplug, plaster, and cement without success. The 13-3/8" casing was run without incident in spite of the break in the 18-5/8" casing.

2110 feet - 10,100 feet.

The 13-3/8" casing shoe was drilled out with water, and a brine starch mud (S.G. 1.27) was used to displace the water from the hole; before drilling ahead the weight of the mud was raised to 1.5 S.G. Initially the mud had a water loss of about 3cc. and a

---

* This correlation is on the basis of lithological and Schlumberger logs and is without palaeontological confirmation. The presence of Eocene limestone at these depths is not taken into account in the cross section (Plate 3) or in the summarized well log (Figure 2).

** Position in situ not confirmed by Schlumberger Log.

Marsh funnel viscosity of 44 secs., and daily additions of saturated brine and starch maintained these properties fairly constant. It was found that the mudstone dispersed in the mud causing high gels and viscosities, and apart from dilution it was found that Q-Broxin was also useful as a thinning agent. This was not true after the 5th February when 10% diesel oil by volume was added to the mud, and emulsified using Carbonox and Q-Broxin; from this stage onwards the only effective method of maintaining a required viscosity was by the addition of brine. In order to remove more of the drilled solids from the mud and hence reduce chemical consumption the surface settling area was greatly increased by the introduction of two settling tanks - this enabled the solid content to be reduced from 27% to 24%. Whilst drilling the 12½" hole it was found that the best hole condition was obtained with a viscosity of about 60 secs. Marsh - a lower viscosity, whilst desirable, was impracticable owing to the low circulation rates obtainable with the helirig pumps. After setting the 9 5/8" casing it was possible to drop the viscosity to 45 secs. Marsh as the annular space velocity obtainable was almost doubled.

Before the 9 5/8" casing was set the oil content of the mud was gradually increased to 15%, and no undue difficulty was experienced in setting the casing at 6880 feet. After cementing the casing there were about 500 linear feet of cement to be drilled out, and the mud was pre-treated with 3 lb/barrel sodium bicarbonate. Although the viscosity dropped to 38 secs. Marsh the water loss was maintained below 5 cc. throughout, and barytes fall-out avoided by the addition of salt-gel and cellofas "B". Drilling proceeded steadily down to 7504 feet, some 79 feet into the second entry of the "Taurian" limestone, when 160 cu.ft. of mud were lost; but no further losses were experienced until 8504 feet, when circulation was completely lost. A total of 2615 cu.ft. was lost at this depth before it was sealed off, and small losses continued when drilling was resumed until further major losses of 2800 cu.ft. at 8825 feet and 690 cu.ft. at 8889 feet occurred. Whilst drilling in the limestone the mud weight was reduced to 1.45 S.G. and viscosity maintained between 45 and 60 seconds Marsh. After the major loss at 8504 feet the mud was loaded with sawdust and allowed to by-pass the screens. At 9760 feet mud treatments appeared to be excessive and drilled solids and lost circulation material were removed gradually with no adverse effects. On completion of drilling the mud viscosity was reduced to 50 secs. Marsh prior to running Schlumberger surveys and drill stem tests.

Mud Control during Drill Stem Testing.

When the hole had been drilled to completion depth cement plugs were set at 8895 feet and 7551 feet and the bottom and top sections of the limestone tested. After the second test the hole was found to have bridged at 7088 feet in the mudstone section above 7425 feet, and three weeks were required to clean out down to the top of the cement plug at 7551 feet. A low water-loss mud was maintained throughout this period (usually less that 2.5 cc.) and the mud weight and viscosity were gradually increased to 1.61 S.G. and 87 secs. Marsh respectively; this made a marked improvement in the returns of cuttings and cavings.

After running and cementing the 7" liner at 7450 feet the S.G. of the mud in the hole was reduced to 1.15. The top cement plug was drilled out and one set from 8307 feet to 8895 feet; the mud in the hole was then displaced with water for the remainder of the testing programme to be completed.

On completion of the testing programme a 7" Baker bridging plug was set at 7360 feet and non-corrosive mud placed in the hole whilst awaiting the commencement of side-tracking operations.

Cumulative Mud Chemical Consumption

Barytes	789.3 tons
Salt	526.1 "
Salt-gel	38.3 "
Bentonite	7.0 "
Starch	95.3 "
Quebracho	0.2 "
Caustic Soda	0.8 "
C.M.C. (Cellofas 'B')	1.3 "
Carbonox	0.4 "
Q-Broxin	1.4 "
Paraformaldehyde	0.4 "
Plaster	8.0 "
Cotton Seed Hulls	6.5 "
Celloflake	1.0 "
Sawdust	30.0 "

Whilst drilling in the mudstone section of the hole the average daily chemical consumption required to maintain the 1.5 S.G. saturated brine mud was :

Barytes	3.2 tons
Salt	2.8 "
Starch	670 lbs.
Diesel Oil	300 galls.

The average mud volume in circulation during this period was 3600 cu.ft.

TESTING.

Sub-thrust Limestone .

An extensive testing programme was carried out in the second entry of the "Taurian" limestone. Twenty-three tests were made in the limestone interval 7425-8897 feet. The interval 7460-7508 feet produced oil at a maximum rate of 1610 bbl/day declining over nine days to 34 bbl/day. Final production rates were : 0.33 MMCF of gas, trace of oil, and 1650 bbl/brine (14210 ppm NaCl) per day. No hydrocarbons were present below 8200 feet.

Test No. 1 : 8470-8897 feet.

The open hole was plugged back to 8897 feet and the two major loss zones at 8504 feet and 8825 feet tested in open hole. A production of 405 cu.ft. of gaseous saline water was obtained in 35 minutes, a minimum salinity of 43,000 ppm NaCl being recorded. Large mud losses over this zone may have caused this value to be somewhat higher than true formation-water salinity.

A reservoir pressure of 3868 psig. at 8895 feet was recorded.

Test No. 2 : 6880-7551 feet.

A further cement plug was set at 7551 feet and the top of the limestone tested in open hole with the packer set in the 9 5/8" casing shoe. Gas of S.G. 0.706 relative to air was produced at rates varying from 2.5 MMCF down to zero; during the test the mudstone section of the hole bridged.

A reservoir pressure of 3056 psig. at 6875 feet was recorded.

Test No. 3 : 7450-7551 feet.

The 7" liner was cemented at 7450 feet and the zones 7501-7512 feet and 7530-7537 feet shot with 2 shaped charges per foot. Gas was procured at varying rates from 50 MCF down to 20 MCF, and 400 cu.ft. of fluid was found in the drill string, consisting of 136 cu.ft. of oil/muddy water/gas emulsion and 264 cu.ft. gaseous water. The lowest recorded water salinity was 44,000 ppm; oil gravity was 0.814 at N.T.P.

No equilibrium reservoir pressure was recorded.

Test No. 4 : 7450-7750 feet.

The cement plug was drilled out to 7750 feet and the open hole under-reamed to 8½". A steady gas flow of 45 MCF was obtained with periodical slugs of emulsion produced to surface. The lowest water salinity recorded was 42,500 ppm NaCl; the oil gravity 0.800 at N.T.P.

A reservoir pressure of 3193 psig. at 7457 feet was recorded.

Test No. 5 : 7450-8307 feet.

The remainder of the plug was drilled out and the hole plugged back to 8307 feet. Water and a small quantity of gas were produced to surface by gas lift - the surface of the water carried a slight trace of oil. Total water production was 1635 cu.ft., and constant salinity at surface 20,800 ppm, declining to 19,400 ppm NaCl for water recovered in the drill pipe.

A reservoir pressure of 3139 psig. at 7448 feet was recorded.

Tests Nos. 6, 7 and 8 : 8200-8307 feet.

The 5" liner was run and cemented at 8200 feet and the open hole below the shoe acidized by squeezing 25 cu.ft of acid to the formation. Test No. 6 was unsuccessful owing to a mechanical failure, but in Test No. 7, 602 cu.ft of gaseous saline water was produced. However, as about 600 cu.ft. of water had been lost after acidizing, some 2000 cu.ft of water was bailed to get a true formation sample. The lowest recorded salinity was 15,800 ppm NaCl. This test proved conclusively the absence of hydrocarbons in this interval.

Reservoir pressures of 3462 psig. at 8200 feet and 3455 psig. at 8192 feet were recorded in Tests No. 6 and 7 respectively.

Test No. 9 : 7900-7950 feet.

A cement plug was set in te bottom of the hole to 8077 feet and the test interval perforated with two shaped charges per foot. It was then acidized with 14 cu.ft. acid squeezed to the formation at a wellhead pressure of 2000 psi. dropping to 1600 psi. The production consisted of 2614 cu.ft gas and 76 cu.ft. water in 33 hours.

A reservoir pressure of 3355 psig. at 7902 feet was recorded.

Tests Nos. 10 and 11 : 7760-7784 feet.

This interval was perforated with two shaped charges per foot, but was not acidized as there was a small loss of fluid on perforation. Test No. 10 did not completely straddle perforations, but produced 2 cu.ft oil; Test No. 11 produced 28 cu.ft. of gaseous saline water but no evidence of oil. Minimum recorded water salinity was 22,000 ppm NaCl.

A reservoir pressure of 3304 psig at 7835 feet was recorded.

Test No. 12 : 7590-7600 feet.

This interval was perforated with four shaped charges per foot, acidized with 42 cu.ft of acid, and straddle-tested. Initial production was 81 cu.ft. of oil-mud emulsion and water, gas-lifted to the surface, followed by 70,000 cu.ft. gas at rates declining from 95 MCF to 14 MCF; no further fluid was gas-lifted to surface. The drill pipe contained 198 cu.ft. fluid of which the top half was 25% emulsion, and the remainder gaseous water only.

A reservoir pressure of 3229 psig. at 7630 feet was recorded.

Test No. 13 : 7688 - 7700 feet

This interval was perforated with four shaped charges per foot and acidized by squeezing 9 cu. ft. of acid to the formation at up to 2500 psi. W.H.P. The production was 85 cu.ft. in 9½ hours, of which 13 cu. ft.was water.

No equilibrium reservoir pressure was recorded.

Test No. 14 : 7460 - 7472 feet

A cement plug was put at 7521 feet and the interval perforated with four shaped charges per foot. Initial production rates rose to 15 MCF after one hour, but it was considered that the zone had a greater potential than this. There was 113 cu. ft. of oil in the drill pipe plus 46 cu. ft. of water; the minimum recorded salinity was 15,200 ppm NaCl.

An equilibrium reservoir pressure of 3181 psig. at 7480 feet was recorded.

Test No. 15 : 7460-7508 feet.

The interval was perforated with four shaped chages per foot and acidized with 40 cu. ft. of acid, squeezed at an initial pressure of 1500 psi. and a final one of 700 psi. The zone produced gas, condensate, and water, the condensate-water ratio increasing throughout the test to a final value of 2:1. The final flow rates were gas 3.3 MMCF, condensate 70 barrels/day, and water 36 barrels/day. The gas production rose steadily throughout the test.

A reservoir pressure of 3173 psig. at 7478 feet was recorded.

Test No. 16 : 7460-7508 feet.

The zone was further acidized with 100 cu. ft. acid; the total water lost to the formation between tests was 6000 cu.ft. Some difficulty was experienced in recovering this water and it had to be air-lifted from the drill pipe to start the well flowing to surface. This test lasted for nine days and during this period produced gas; gas and condensate plus a trace of water; gas and oil with a trace of water; gas and oil with increasing quantities of water. After the well had been flowing for two days (at approximately 8 MMCF gas) a change in character in the nature of the flow was observed and the production rates were gas 4.5 MMCF, oil 1300 bbl/day, water trace only. The oil production rose to a maximum of 1610 bbl/day and then declined steadily throughout the remainder of the test. The well was continually beaned back in an attempt to prevent the water coming in, but without success, and at the end of the test the flow rates were gas 0.7 MMCF, oil 34 bbl/day and water 116 bbl/day.

A reservoir pressure of 3181 psig. at 7473 feet was recorded.

Test No. 17 : 7580-7620 feet.

The zone 7460 - 7508 feet was sealed off on completion of Test No. 16 with lost circulation material, and the cement plug drilled out to 7650 feet. The interval 7580 - 7620 feet was perforated with eight shaped charges per foot, and acidized with 100 cu.ft. of acid, squeezed to the formation at 1000 psi. in five hours. The production rate reached a maximum of 20.9 MCF, and declined to 7.7 MCF at the end of the test. The drill pipe contained 35 cu. ft. of oil, emulsion, and water, and 270 cu.ft. of gaseous water.

A reservoir pressure of 3237 psig. at 7592 feet was recorded.

Tests Nos. 18 and 19 : 7580-7620 feet.

The interval was further acidized with two batches of 100 cu.ft. of acid, and Test No. 18 produced 27000 cu. ft. of gas and 394 cu.ft. of fluid, of which 15 - 20 cu.ft. was oil, in 21 hours; Test No. 19 produced 38,000 cu.ft. of gas, 32 barrels of oil, and 160 barrels of water in 42 hours.

Reservoir pressure of 3218 psig. at 7592 feet and 3249 psig. at 7592 feet were recorded - the high values being due to residual squeeze pressures as a result of acidization.

Test Nos. 20 and 21 : 7830-7860 feet.

The cement plug was drilled out to 7880 feet and the zone 7830 - 7860 feet perforated with 180 shaped charges. Test No. 20 produced 1200 cu.ft. of gas, 64 cu.ft. of water, and 1 gallon of oil in just under nine hours, the rate of production declining from 420 cu.ft./hour initially to 90 cu.ft./hour.

The zone was then acidized with 40 cu. ft. of acid and Test No. 21 produced 5000 cu.ft. of gas, 237 cu.ft. of water, and 3 cu.ft. of oil in 24½ hours; final gas flow rates were about 2.0 MCF.

Reservoir pressures of 3314 psig. at 7846 feet and 3333 psig. at 7845 feet. were recorded - the high figure in Test No. 21 presumably being a residual squeeze pressure as before.

Test No. 22 : 7460-7508 feet.

A Baker type "N" bridge plug was set in the 5" liner at 7520 feet and a packer set at the bottom of the 9-5/8" casing so that the well could be flowed at a minimum back pressure. Initial flow rates were gas 5.7 MMCF, oil 115 barrels/day and water 1473 barrels/day. The oil production rose to a maximum of 159 barrels per day two days after the well was brought in, but thereafter declined steadily until it became only a trace (less than 5 barrels/day). The final production rates after 23 days were gas 0.33 MMCF, oil a trace, water 1650 barrels/day.

Test No. 23 : 7460-7508 feet.

A subsequent run with the amerada pressure gauge gave a reservoir pressure of 3136 psig. at 7459 feet; this test was made to obtain a final reservoir pressure.

This was the final test in the "Taurian" limestone below the thrust and a 7" Baker bridge plug was set at 7360 feet.

The accompanying graph (Fig. 3) shows the variation of recorded reservoir pressure with depth.

Test No. 24.

This test was carried out after perforating, using a type C tester. The packer was set at 1968 feet, giving a 40 cu.ft. sump, the air chamber being 4.1 cu.ft.

Over-thrust Limestones.

After the drilling of two deviated holes, Puri 1A and Puri 1B, it was decided to carry out more testing (tests 24 to 30) in the higher part of the well. On 2nd September 1959, viscous mud was spotted in the well from 2,400 feet to 2,200 feet and on top of this a cement plug was placed, thus sealing off the deviated hole Puri 1B. The cement plug was then drilled out to 2,070 feet. The 9-5/8" and 13-3/8" casing were perforated as follows:

Zone A - 3rd September 1959

Perforated 1980-1984 feet at 4 shots/foot only, owing to misfire.

1984-1995 feet at 8 shots/foot.

1995-1996 feet at 4 shots/foot only, owing to misfire.

Perforation Record Number 362

Perforated 1980-1996 feet at 4 shots/foot on 5th September 1959.

Perforation Record Number 363

Zone B - 8th September 1959

Perforated 1950-1968 feet at 8 shots/foot.

Perforation Record Number 364

Zone C - 12th September 1959

Perforated 1850-1870 feet at 8 shots/foot.

Perforation Record Number 365

Zone D - 13th September 1959

Perforated 1760-1780 feet at 8 shots/foot.

Perforation Record Number 366

Seven tests were carried out through these perforations. Only salt water and a small quantity of gas were produced from the tested zones. The gas contained less than 1% of ethane with higher hydrocarbons.

The well was finally plugged on 16th September 1959.

ZONE A: 1980 - 1996 feet.

A 7200 psi pressure element was used in the amerada, which was set at 1990 feet. After 75 minutes initial shut-in time the disc valve was ruptured and production initiated. Plugging occurred several times but each time was cleared as the pressure built up. Because of the low productivity of the formation no equilibrium reservoir pressure was obtained.

During a flowing time of 1035 minutes only 430 cubic feet of gas and air were produced through the meter and production of other fluids into the drill pipe consisted of 39 cubic feet sump mud and 14 cubic feet brine of specific gravity 1.03, salinity 14,700 ppm NaCl.

Test No.25

The zone 1980-1996 feet was reperforated over the 16 feet with a further 4 shaped charges per foot. The amerada and packet depths were the same as for Test No.24, but this test was run without a disc valve in the testing string. Flowing time was 1065 minutes, during which only 57 cubic feet of gas was produced through the meter, and on completion the drill pipe was found to contain 13 cubic feet of brine-contaminated mud. A shut-in pressure period of 480 minutes was allowed after the flow and before pulling out, but equilibrium pressure was not reached.

A sample collected from the testing string just above the test was quite watery and gas-cut, specific gravity 1.05. The salinity of 9700 ppm NaCl confirmed the entry of saline water. Circulating fluid at this stage had a salinity of 5000 ppm NaCl.

Test No.26

The zone 1980-1996 feet was now acidized with 30 cubic feet of 50/50 acid with 5% Murodine squeezed through the perforations and re-tested. The formation breakdown pressure was 1350 psi, the squeeze pressure 1200 psi.

The test followed a pattern similar to that of Tests 24 and 25, but a greater volume of gas was produced (flowing time 745 minutes produced 598 cubic feet of gas) and also an almost clear brine (15 cubic feet) with a salinity of 17,600 ppm NaCl. (Chloride ion derived from the acid was probably present).

Again equilibrium was not reached even after a shut-in time of 4 hours.

ZONE B: 1950 - 1968 feet.

Test No. 27

After placing a cement plug across the previous perforations, the casing was perforated from 1950-1968 feet and a further drill stem test carried out, with the packer sat at 1926 feet.

No equilibrium reservoir pressure could be obtained and no brine was produced. The flowing time was 630 minutes and the volume of gas produced was 58 cu.ft.

Test No.28

The Zone was acidized with 30 cubic feet of acid and retested with packer set at 1926 feet. 31 cu.ft. of brine-contaminated mud and 47 cu.ft. of clear brine of from 28,000 to 32,000 ppm NaCl were produced, the latter probably contaminated with acid although the pH of the brine was only 6.5. 1685 cu.ft. of gas at a diminishing rate was produced through the gas meter.

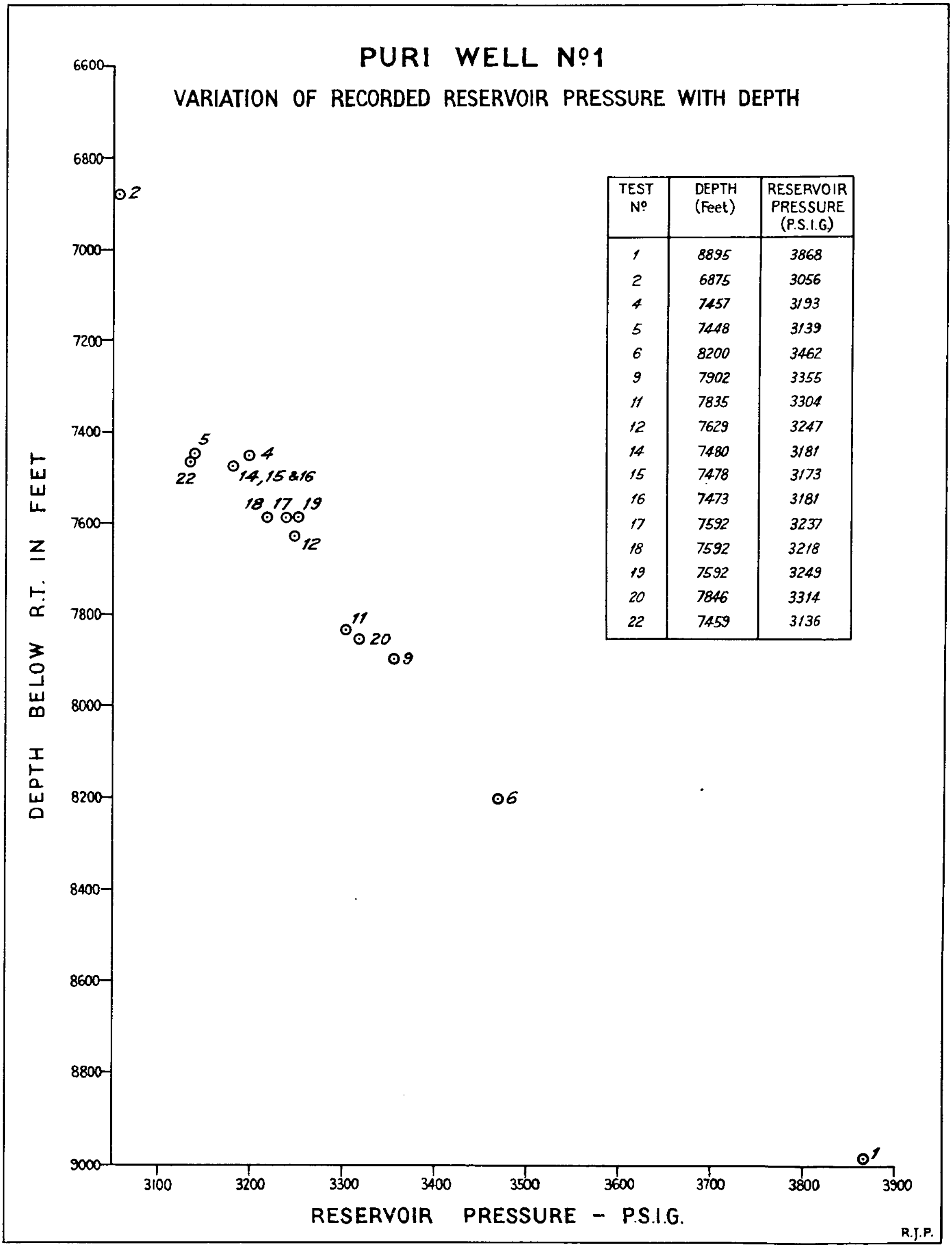
An initial equilibrium reservoir pressure of 805 psi at 1960 feet was obtained almost immediately, but after flowing for 440 minutes it was found that a final shut-in-time of 240 minutes was far from sufficient to obtain a second equilibrium reservoir pressure. The final shut-in pressure obtained was only about 600 psi.

ZONE C: 1850 - 1870 feet.

Test No.29

Because of the results obtained in previous tests, the zone 1850 to 1870 feet was acidized immediately after perforating and before testing.

The packer was set at 1830 feet and the flowing time was 425 minutes. 1156 cu.ft of gas was passed through the meter and production to the drill pipe consisted of 15 cu.ft. of mud and 54 cu.ft. of brine of salinity between 26,000 and 29,000 ppm NaCl.



PURI WELL Nº1

VARIATION OF RECORDED RESERVOIR PRESSURE WITH DEPTH

TEST Nº	DEPTH (Feet)	RESERVOIR PRESSURE (P.S.I.G.)
1	8895	3868
2	6875	3056
4	7457	3193
5	7448	3139
6	8200	3462
9	7902	3355
11	7835	3304
12	7629	3247
14	7480	3181
15	7478	3173
16	7473	3181
17	7592	3237
18	7592	3218
19	7592	3249
20	7846	3314
22	7459	3136

Fig. 3

The initial shut-in pressure reached equilibrium readily, giving a reservoir pressure of 767 psi at 1852 feet. The rate of flow decreased rapidly and no final shut-in pressure was attempted.

ZONE D: 1760 - 1780 feet.

Test No. 30

The zone was also acidized immediately after perforating. The packer was set at 1742 feet and the flowing time was 480 minutes. Production through the meter was 9015 cu. ft., and the pipe contained 15 cu.ft mud and 70 cu.ft clear brine of 16,000 to 17,000 ppm NaCl.

Equilibrium pressure of 704 psi at 1764 feet was obtained almost immediately on opening the tester.

MUD CONTROL

During the tests the drilling mud control consisted of watering back only, when mud became contaminated by acid, brine, or cement. Wherever possible contaminated mud was by-passed to waste.

Immediately before any test the mud was circulated fully and tested to obtain the new charcteristics, for comparison with fluid produced to the drill pipe during testing.

NOTE : Total volume of gas measured is total meter reading and includes fluid volume - B.M.R.

OIL ANALYSES : PURI WELL No. 1.

TEST No.	PT.3	PT.4	PT.10	DST.12	DST.14	DST.15	DST.16	DST.17	DST.19	DST.20	DST.22
INTERVAL ft.	7450-7551	7450-7750	7760-7784	-	7460-7472	7460-7508	7460 - 7508	7580 - 7620	7580 - 7620	7830 - 7860	7460 - 7508
Specific Gravity at 60°F/60°F	0.820	0.8125	0.8375	0.816	0.836	0.7725	0.8135	0.833	0.8435	0.850	0.8415
Distillation 1P 123											
1BP °C	84	80	86	69	110	58	55	79	168	170	135
2% Vol Recovered at °C	111	99	130	96.5	145	92	75	130	185	196	160.5
5% " " "	125	108	146	109.5	158	100	89.5	144	195	210.5	171
10% " " "	144.5	121	163	124	175	109.5	107	166	205.5	226.5	187
20% " " "	170	142.5	190	151	206	120	140	196.5	225.5	250.5	211
30% " " "	198.5	170.5	224	180	232.5	129.5	167	222	243	267	236
40% " " "	224	201	249	209	256	140.5	208	245	259	281	255
50% " " "	248	230	266	237	272	153	241	263.5	275	293.5	272
60% " " "	269	258.5	287	262	289.5	166.5	270	282	291	307	290
70% " " "	288	282	309	285	308	189	298	302	312.5	322	311
80% " " "	310	308	334	310	326.5	216	329.5	326	340	341	339
90% " " "	341	343	367	347	359.5	254	372	357	366	372.5	373.5
FBP "	390	371.5	384	400	386	321	394	391	384	>400	>400
Total Distillate %	99	96	97	99	97	99	97	98	96	97	96.5
Residue %	1	4	3	1	3	1	3	2	4	3	3.5
Loss %	0	0	0	0	0	0	0	0	0	0	0
Sulphur Content % wt.	0.06	0.05	0.12	0.06	0.07	0.03	0.11	0.11	0.05	0.08	0.05
Viscosity at 70°F cs.	2.62	2.20	3.60	2.37	3.84	1.11	2.27	3.51	4.87	6.30	4.52
" 100°F cs.	1.91	1.67	2.70	1.75	2.69	0.89	1.74	2.59	3.31	4.10	2.99
Pour Point °F	25	25	30	30	35	30	40	40	45	50	50
Asphaltenes % wt.	-	-	0.06	-	0.05	-	0.05	<0.05	<0.05	<0.05	<0.05
Water Content %vol.	-	-	0.05	-	nil	-	nil	0.1	trace	trace	trace
Water & Sediment %vol.	-	-	-	-	-	-	nil	-	-	-	-
Wax Content % wt.	7.0	6.5	9.4	7.9	9.2	0.5	6.2	8.8	16.8	13.3	8.7
Melting Point of Wax °F	96	98	98	98	99	109	107	98	88	97	106
Aniline Point °C	65.3	63.8	-	64.3	68.8	55.1	64.0	68.4	70.9	73.3	69.2
Colour ASTM	4-	4½-	-	-	-	1.5+	5	6	6	>8	8-
Vanadium ppm	-	-	-	-	-	-	0.02	-	-	-	-
Appearance	Light Brown Oil	Light Brown Oil	Black Oil	Light Brown Oil	Black Oil	Yellow Oil	Medium Brown Oil	Dark Brown	Dark Brown	Dark Brown	Dark Brown

GAS ANALYSES : PURI NO. 1 WELL

DRILL STEM TEST NO. 1 - 8471' - 8897'

Constituent	% mol
Nitrogen	3.3
Carbon dioxide	22.3
Methane	71.3
Ethane	2.5
Propane	0.4
Isobutane	0.1
n-Butane	0.1
Total	100.0
Air in original	0.4
S.G. @ 60°F, 1 atmos and air-free basis (calc.)	0.8048

Remarks: (1) The helium content was less than 0.01% mol.
(2) The other sample tube contained only air.

DRILL STEM TEST NO. 2 - 6880' - 7551'

Constituent	% mol
Carbon dioxide	3.5
Methane	85.6
Ethane	6.7
Propane	2.3
Isobutane	0.7
n-Butane	0.4
Isopentane	0.3
n-Pentane	0.1
Hexanes	0.4
Total	100.0
S.G. @ 60°F, 1 atmos, helium and air-free basis (calc.)	0.6800
Air in original	2.9
Helium in original	0.02

DRILL STEM TEST NO. 3 - 7450' - 7551'

Constitutent	Date Sampled					
	12-9-58		13-9-58		14-9-58	
	(1)	(2)	(1)	(2)	(1)	(2)
Nitrogen (% mol)	Nil		1.2	0.6	0.3	0.8
Carbon Dioxide "	2.6		3.1	3.0	6.8	6.8
Methane "	83.0		75.6	75.9	63.6	64.5

Constitutent		Date Sampled					
		12-9-58		13-9-58		14-9-58	
		(1)	(2)	(1)	(2)	(1)	(2)
Ethane	(% mol)	8.7		8.5	8.5	12.0	12.0
Propane	"	3.3		4.1	4.1	7.2	6.9
Isobutane	"	1.9		1.8	1.7	2.8	2.6
n-Butane	"	0.1		1.6	1.6	2.6	2.6
Isopentane	")			1.9	2.0	2.1	1.9
n-Pentane	")	0.4		0.3	0.4	0.7	0.6
Hexanes	")	-		1.9	2.2	1.9	1.3
Total		100.0		100.0	100.0	100.0	100.0
Air in original		6.4	100.0	0.6	1.8	1.3	2.9
S.G. @ 60°F, 1 atmos (calc.)		0.6940		0.8185	0.8254	0.9515	0.9155

DRILL STEM TEST NO. 4 - 7450' - 7750'

Constituent	% mol
Carbon dioxide	2.9
Methane	83.9
Ethane	8.2
Propane	2.6
Isobutane	0.5
n-Butane	0.3
Isopentane	0.3
n-Pentane	0.5
Hexanes (average)	0.4
Total	100.0
Air in original	8.9
S.G. @ 60°F, 1 atmos (calc)	0.6941

DRILL STEM TEST NO. 5 - 7450' - 8307'

Constituent		Sample	
		(1)	(2)
Nitrogen	(% mol)	2.6	2.3
Carbon dioxide	"	10.2	10.2
Methane	"	76.5	76.7
Ethane	"	5.8	6.1
Propane	"	2.1	2.1
Isobutane	"	1.0	0.8
n-Butane	"	0.4	0.4
Pentanes	"	0.7	0.6
Hexanes	"	0.7	0.8
Total	"	100.0	100.0
Air in original	"	2.9	0.1
S.G. @ 60°F, 1 atmos (calc.)		0.7679	0.7656

DRILL STEM TEST NO. 7 - 8200' - 8307'

Constituent	% mol
Carbon dioxide	0.9
Methane	91.7
Ethane	5.8
Propane	1.2
Isobutane	0.2
n-Butane	0.1
Pentanes	0.1
Total	100.0
Air in original	0.3
S.G. @ 60°F, 1 atmos (calc.)	0.6106

Tests Nos. 6, 7 and 8 were over the same interval.

DRILL STEM TEST NO. 9 - 7900' - 7950'

Constituent		Sample	
		(1)	(2)
Methane	(% mol)	90.0	90.0
Ethane	"	6.9	6.7
Propane	"	2.1	2.2
Isobutane	"	0.6	0.8
n-Butane	"	0.2	0.1
Pentanes	"	0.2	0.2
Total	"	100.0	100.0
Air in original	"	3.4	2.9
S.G. @ 60°F, 1 atmos (calc.)	"	0.6257	0.6272

DRILL STEM TEST NO. 12 - 7590' - 7600'

Constituent		Samples	
		(1)	(2)
Carbon dioxide	(% mol)	4.3	
Methane	"	81.7	
Ethane	"	8.0	
Propane	"	2.9	
Isobutane	"	0.8	
n-Butane	"	0.7	
Isopentane	"	0.5	
n-Pentane	"	0.1	
Hexanes (average)	"	1.0	
Total	"	100.0	
Air in Original	"	1.4	100.0
Helium in original	"	0.01	

S.G. @ 60°F, 1 atmos, helium and air-free basis (calc.)	0.7259

DRILL STEM TEST NO. 14 - 7460' - 7472

Constituent		Samples	
		(1)	(2)
Carbon dioxide	(% mol)	2.2	Arrived broken at seal
Methane	"	82.3	
Ethane	"	10.2	
Propane	"	3.1	
Isobutane	"	0.6	
n-Butane	"	0.6	
Isopentane	"	0.3	
n-Pentane	"	0.1	
Hexanes (average)	"	0.6	
Total	"	100.0	
Air in original	"	0.5	
Helium in original	"	0.01	
S.G. @ 60°F, 1 atmos, helium and air-free basis (calc.)		0.6990	

DRILL STEM TEST NO. 15 - 7460' - 7508'

Constituent		Samples		
		(1)	(2)	(3)
Nitrogen	(% mol)	1.4	3.5	0.9
Carbon Dioxide	"	2.4	4.0	3.9
Methane	"	84.4	81.2	83.2
Ethane	"	6.7	6.6	6.9
Propane	"	2.3	2.1	2.3
Isobutane	"	0.7	0.7	0.8
n-Butane	"	0.8	0.6	0.6
Isopentane	"	0.5	0.5	0.5
n-Pentane	"	0.2	0.2	0.2
Hexanes (average)	"	0.6	0.6	0.7
Total	"	100.0	100.0	100.0
Air in original	"	2.1	5.4	16.8
S.G. @ 60°F, and 1 atmos (calc.)		0.6925	0.7111	0.7070

Remarks: The helium concentration was less than 0.01 % mol.

DRILL STEM TEST NO. 16 - 7460' - 7508'

Constituent		Samples			
		(1)	(2)	(3)	(4)
Carbon Dioxide	(% mol)	4.0	4.0	3.8	3.8
Nitrogen	"	-	-	0.7	0.8
Methane	"	84.7	84.5	83.4	83.2
Ethane	"	6.9	6.9	6.9	6.9
Propane	"	2.3	2.3	2.4	2.4
Isobutane	"	0.7	0.7	0.8	0.7
n-Butane	"	0.5	0.6	0.6	0.7
Isopentane	"	0.4	0.4	0.5	0.5
n-Pentane	"	0.1	0.1	0.1	0.2
Hexanes	"	0.4	0.5	0.8	0.8
Total	"	100.0	100.0	100.0	100.0
Air in original	"	2.4	1.7	1.5	2.2
S.G. @ 60°F, 1 atmos (calc.)		0.6894	0.6935	0.7068	0.7093

Remarks; The helium content of each sample was less than 0.01% mol. Each analysis shows that the hexanes concentration is higher than that of the pentanes. Although this is somewhat unexpected, it should be noted that average spectral data were used for the hexanes when calculating the results. If, however, one of the hexanes is present in these samples in predominant amounts, then the accuracy of the hexanes concentration obtained by using average data would be affected.

DRILL STEM TEST NO. 17 - 7580' - 7620'

Constituent		Samples	
		(1)	(2)
Carbon Dioxide	(% mol)	5.8	5.7
Nitrogen	"	0.5	0.4
Methane	"	75.7	76.9
Ethane	"	8.6	8.7
Propane	"	3.7	3.5
Isobutane	"	1.4	1.0
n-Butane	"	1.1	1.1
Isopentane	"	1.1	0.9
n-Pentane	"	0.2	0.5
Hexanes (average)	"	1.9	1.3
Total	"	100.0	100.0
Air in original	"	1.3	0.7
S.G. @ 60°F, 1 atmos (calc.)		0.8063	0.7839

Remarks: The remarks on Drill Stem Test 16 also apply to these analyses.

DRILL STEM TEST NO. 19 - 7580' - 7620'

Constituent		Samples			
		As Received		H_2-Free	
		(1)	(2)	(1)	(2)
Hydrogen	(% mol)	6.5	7.2		
Carbon Dioxide	"	6.4	5.8	6.8	6.3
Methane	"	53.0	55.3	56.7	59.6
Ethane	"	15.9	16.0	17.0	17.2
Propane	"	7.8	7.6	8.3	8.2
Butanes	"	5.1	4.7	5.5	5.1
Pentanes	"	2.6	1.9	2.8	2.0
Hexanes (average)	"	2.7	1.5	2.9	1.6
Heptanes & heavier	"	trace	trace	trace	trace
Total	"	100.0	100.0	100.0	100.0
Air in original	"	26.7	16.0	26.7	16.0
S.G. @ 60°F, 1 atmos, (air & helium free basis) (calc.)		0.9421	0.8796	1.0034	0.9419

Remarks: The helium content of each sample was less than 0.01 % mol. The hexanes concentration of each sample was obtained using average spectral data when calculating the results. If one of the hexanes is present in predominant amounts, then the accuracy of the hexanes concentration obtained by using average data would be affected.

The hydrogen content found in each of the samples is unexpected, Duplicate determinations were made on each sample, however, and confirmed the presence of this gas in the two samples. It is considered possible that contamination of the natural gas with hydrogen occurred during the acid treatment which took place before the formation test, the hydrogen being produced by reaction of the acid with the metal casing.

DRILL STEM TEST No. 22 - 7460-7508 feet.

Constituent		Sample	
		(1)	(2)
Carbon dioxide	(% mol)	6.1	6.9
Methane	"	82.4	81.6
Ethane	"	6.6	6.6
Propane	"	2.5	2.4
Isobutane	"	0.7	0.7
n-Butane	"	0.6	0.6
Isopentane	"	0.6	0.6
n-Pentane	"	0.1	0.1
Hexanes (average)	"	0.4	0.5
Total	"	100.0	100.0
Air in original	"	6.2	13.3
Helium in original	"	0.01	0.01
S.G. @ 60°F, 1 atmos air and helium-free basis (calc.)		0.7159	0.7252

DRILL STEM TEST No. 24 : 1980 - 1996 feet

Constituent	Sample 1 % mol.
Carbon Dioxide	-
Methane	99.7
Ethane (& heavier)	0.3
Total	100.0
Air in original	22.6
Helium in original	0.01
Specific Gravity at 60°F, 1 atm. Air and helium-free basis (calculated)	0.5562

DRILL STEM TEST No. 26 : 1980 - 1996 feet

Constituent	Sample 1 % mol.	Sample 2 % mol.
Carbon Dioxide	11.6	12.7
Methane	88.1	87.1
Ethane (& heavier)	0.3	0.2
Total	100.0	100.0
Air in original	19.0	5.9
Helium in original	0.01	0.01
Specific Gravity at 60°F, 1 atm. Air and helium-free basis (calculated)	0.6691	0.6793

DRILL STEM TEST No.28 : 1950 - 1968 feet

Constituent	Sample 1 % mol.	Sample 2 % mol.
Carbon Dioxide	22.2	15.4
Methane	77.7	84.5
Ethane (& heavier)	0.1	0.1
Total	100.0	100.0
Air in original	7.0	1.7
Helium in original	0.01	0.01
Specific gravity @ 60°F, 1 atm. Air and helium-free basis (calculated)	0.7712	0.7051

DRILL STEM TEST No.29 : 1850 - 1870 feet

Constituent	Sample 1 % mol.
Carbon Dioxide	-
Methane	99.8
Ethane (& heavier)	0.2
Total	100.0
Air in original	5.9
Helium in original	0.01
Specific gravity @ 60°F, 1 atm. Air & helium-free basis (calculated)	0.5558

DRILL STEM TEST No.30 : 1760 - 1780 feet

Constituent	Sample 1 % mol.	Sample 2 % mol.
Carbon Dioxide	16.6	-
Methane	83.1	-
Ethane (& heavier)	0.3	-
Total	100.0	-
Air in original	3.5	100.0
Helium in original	0.01	-
Specific gravity @ 60°F, 1 atm. Air and helium-free basis (calculated)	0.7177	-

WATER ANALYSIS : PURI WELL NO. 1

DRILL STEM TEST NO.	1		3		4		5		8		9	
Reaction (pH value)	6.00		6.65		6.50		8.0		8.1		11.85	
Specific Gravity @ 20°C	1.031		1.055		1.033		1.020		1.014		1.015	
	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)
Total Solids	46965		68900		46160		24794		19943			
Dissolved Mineral Solids												
(a) **Positive (basic) Radicals**												
Ca	497.7	24.833	1096	54.690	487.6	24.331	248.7	12.410	308.0	15.369	978.0	48.802
Mg	52.2	4.290	121	9.946	107.8	8.861	51.3	4.217	45.4	3.732		
Na	16310	709.121	23830	1036.61	15970.0	694.695	8494	369.319	6459.0	280.966	7250.0	315.375
K	1444.7	36.950	1930	49.41	1220.0	31.232	642.6	16.438	508.0	13.005	918.0	23.500
Fe^2	172.2	6.168					7.7	0.275	140.7	5.037		
(b) **Negative (acid) Radicals**												
HCO_3	1098.7	18.008	914	14.986	1315.0	21.566	1944.4	31.882	1210	19.844		
SO_4	389.9	8.117	636	13.229	884.0	18.387	115.9	2.413	292	6.074	772.0	16.057
Cl	26260	740.532	39638	1117.792	25433.0	717.211	12541	353.656	10152	286.286	12523.0	353.148
BO_3	624.9	14.590			346.0	8.096	539.7	12.600	580	13.572	86.7	2.028
Br	41.2	0.515			20.0	0.250	42.4	0.530	45	0.565	15.3	0.191
NO_3					-						2.2	0.035
OH											257.2	15.123
CO_3											39.6	1.318
Colloidal Matter												
SiO_2	81.0		248		222.0		111.0				10.0	
Fe_2O_3			264								6.0	
Al_2O_3			52									
Hypothetical Compounds*												
$Fe(HCO_3)_2$	549						23		448			
$CaSO_4$	553		900		188				38		1093	
$Ca(HCO_3)_2$	960		1215		1748		1006		1210		66	
$CaCO_3$											406	
$CaCl_2$	271		1469								905	
$Ca(OH)_2$											560	
$MgSO_4$					533				224			
$Mg(HCO_3)_2$							309					
$MgCl_2$	204		474									
Na_2SO_4					480		171		126			
$NaHCO_3$							1258					
NaCl	40571		60600		40102		19805		15976		18315	
NaBr	61				26		55		58		20	
$NaNO_3$											3	
Na_3BO_3	960				533		829		893		133	
KCl	2755		3684		2328		1226		970		1752	

(a) Milligrams per litre
(b) Milligram equivalents per litre

DRILL STEM TEST NO.	11		12		13		14		15		16	
Reaction (pH value)	7.20		6.2		6.75		6.2		7.1		8.2	
Specific Gravity @ 20°C	1.018		1.016		1.052		1.014		1.027		1.011	
	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)
Total Solids	27519		23614		74534		18300		34915		17216	
Dissolved Mineral Solids												
(a) Positive (basic) Radicals												
Ca	66.9	3.338	1327.2	66.221	19986	997.301	939.6	46.882	1073.4	53.568	240.0	11.976
Mg	22.9	1.882	40.8	3.354	43.7	3.592	56.1	4.611	103.7	8.524	45.0	3.699
Na	9697	421.626	6776	294.620	3584	155.832	5270	229.140	11032	479.671	5600.0	243.600
K	866.2	22.157	610. 5	15.614	650.3	16.634	467.9	11.991	977.9	25.010	496.0	12.697
Fe^2			346.2	12.393	3560	127.519	147.6	5.283	102.8	3.681		
(b) Negative (acidic) Radicals												
HCO_3	1450.7	23.791	592.5	9.716	926	15.186	1469.0	24.092	852.0	13.973	1452	23.813
SO_4	677.5	14.791	637.0	13.263	611.3	12.715	366.0	7.619	554.4	11.534	332	6.906
Cl	14343	404.473	12904	363.893	44867	1265.249	9114	257.015	19028	536.590	8310	234.342
BO_3	326.4	7.621	255.5	5.966	33.1	0.773	397.6	9.284	317.2	7.406	484	11.326
Br	41.0	0.513	21.2	0.265	24.0	0.300	10.6	0.132	16.0	0.200	40	0.499
NO_3												
OH												
CO_3												
Colloidal Matter												
SiO_2	65.0		135.0		18.0		69.0		113.0			
Fe_2O_3	13.0											
Al_2O_3												
Hypothetical Compounds												
$FeSO_4$			203		966							
$Fe(HCO_3)_2$			864		1350		470		327			
FeCl					6313							
$CaSO_4$			721				519		785			
$Ca(HCO_3)_2$	271						1524		834		971	
$CaCl_2$			3088		55347		1135		1761			
$Ca(OH)_2$												
$MgSO_4$												
$Mg(HCO_3)_2$	138										271	
$MgCl_2$			160		171		220		406			
Na_2SO_4	1001										491	
$NaHCO_3$	1560										683	
NaCl	22264		16859		9047		12844		27596		12957	
NaBr	53		27		31		14		21		51	
$NaNO_3$												
Na_3BO_3	502		393		51		611		487		745	
KCl	1652		1164		1240		894		1865		947	

DRILL STEM TEST NO.	17		18		19		20		21		22	
Reaction (pH value)	6.2		6.4		6.15		7.25		5.80		7.90	
Specific Gravity ● 20°C	1.032		1.017		1.014		1.018		1.016		1.012	
	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)
Total Solids	45866			26461	13547		27076		24143		18611	
Dissolved Mineral Solids												
(a) **Positive (basic) Radicals**												
Ca	6677.0	333.182	2242.0	111.876	1307.3	65.216	276.8	13.812	887.6	44.288	95.7	4.775
Mg	390.3	32.080	173.4	14.253	109.9	9.032	14.6	1.200	72.3	5.942	36.0	2.959
Na	6782	294.881	6762	294.012	3301	143.531	9437	410.310	7334	318.854	6403	278.390
K	597.6	15.284	587.9	15.035	296.3	7.578	861.6	22.035	655.2	17.031	575.7	14.723
Fe^2	2040.0	73.073	300.0	10.740	143.4	5.136	51.1	1.830	458.1	16.408		
(b) **Negative (acidic) Radicals**												
HCO_3	407.4	6.682	753.3	12.354	117.3	1.922	586.5	9.613	308.7	5.059	1179.0	19.323
SO_4	327.1	6.810	384.1	7.996	191.5	3.987	533.5	11.107	408.8	8.510	369.3	7.688
Cl	26004	733.813	14938	421.252	7845	221.229	14915	420.603	13335	376.047	9135	257.607
BO_2	108.7	2.538	193.9	4.527	113.7	2.655	326.5	7.632	511.4	11.940	658.0	15.364
Br	42.4	0.530	16.0	0.200	16.0	0.200	50.5	0.632	51.9	0.649	53.2	0.665
NO_3												
OH												
CO_3												
Colloidal Matter												
SiO_2	185.0		125.0		85.0		29.0		91.0		82.0	
Fe_2O_3											} 9.0	
Al_2O_3												
Hypothetical Compounds												
$FeSO_4$	517				244				646			
$Fe(HCO_3)_2$	594		955		171		163		550			
FeCl	3776								180			
$CaSO_4$			544		53		410					
$Ca\ (HCO_3)_2$			131				631				387	
$CaCl_2$	18491		5676		3576				2458			
$Ca(OH)_2$												
$MgSO_4$							72					
$Mg(HCO_3)_2$											216	
$MgCl_2$	1528		679		430				283			
Na_2SO_4							275				646	
$NaHCO_3$											973	
NaCl	17059		16911		8224		23276		17904		14210	
NaBr	55		21		24		75		77		79	
$NaNO_3$												
Na_3BO_3	167		298		175		502		786		1011	
KCl	1140				565		1643		1268		1098	

DRILL STEM TEST NO.	24		26		28		29		30	
Reaction (pH value)	12.6		6.8		5.6		5.5		5.5	
Specific Gravity @ 20°C	1.017		1.015		1.029		1.034		1.022	
	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)
Total Solids	19930		19310		36710		42715		28240	
Dissolved Mineral Solids										
(a) Positive (basic) Radicals										
Ca	16.8	0.838	2503	124.900	9050	451.595	12580	627.742	8057	402.044
Mg			166	13.643	314	25.811	326	26.797	250	20.550
Na	7657	333.090	3448	49.988	3064	133.284	1812	78.822	1213	52.765
K	426	10.906	630	16.128	528	13.511	547	14.003	456	11.674
Fe^{+2}			260	9.308	447	16.003	274	9.809	173	6.193
(b) **Negative (acidic) Radicals**										
HCO_3			1676	27.486	1130	18.532	683	11.201	1043	17.105
SO_4	877	18.242	142	2.954	58	1.206	26128	736.809	89	1.851
Cl	8413	237.246	9842	277.544	21785	614.337			16590	467.838
BO_2	101	2.368	152	3.557	182	4.258	132	3.089	101	2.363
Br	3	0.037	17	0.213	12	0.150	11	0.137	4	0.050
NO_3										
OH	602	35.411								
CO_3	1504	50.133								
Colloidal Matter										
SiO_2	329		457		126		97		220	
Fe_2O_3	Trace									
Al_2O_3			19		12		4.0		47	
Hypothetical Compounds										
$FeSO_4$										
$Fe(HCO_3)_2$			827		1423		872		551	
FeCl										
$CaSO_4$					82		171		126	
$Ca(HCO_3)_2$	42		1474		205		113		885	
$CaCl_2$			5759		24856		34623		21605	
$Ca(OH)_2$										
$MgSO_4$										
$Mg(HCO_3)_2$										
$MgCl_2$			650		1229		1276		979	
Na_2SO_4	1296									
$NaHCO_3$	2613									
NaCl	13230		8417		7431		4219		2708	
NaBr	38		22		15		14			
$NaNO_3$										
Na_3BO_3	156		234		280		203		155	
KCl	813		1202		1008		1044		870	
NaOH	1416									

CONCLUSIONS.

The drilling of Puri No. 1 was of considerable interest structurally, showing the anticline to be thrust-faulted and complicated.

The "Taurian" and "Kereruan" limestones were found to be similar in lithology to outcrop and occurred as pelagic and shoal limestones with poor porosity but considerable fracturing. The Eocene was generally recrystallized. The Cretaceous mudstone above the thrust showed a remarkable degree of slickensiding and had obviously been subjected to severe movement.

It is not possible to define completely the complex faulted structure from the evidence of one well, but the cross-section drawn is considered to be the most likely interpretation on general principles. However, if encouraging production were obtained from the Tertiary limestones, a second well would be necessary before even an initial appraisal of the structure and reservoir characteristics could be made. The possibility remains that production might be obtained from "Muruan" sandstones underlying the thrust; the investigation of this would require a well to be located on, or very near to, the crest of the structure, and it is doubtful if such a location could be used to test the Tertiary limestones underlying the thrust.

REFERENCES.

Unpublished Company reports:

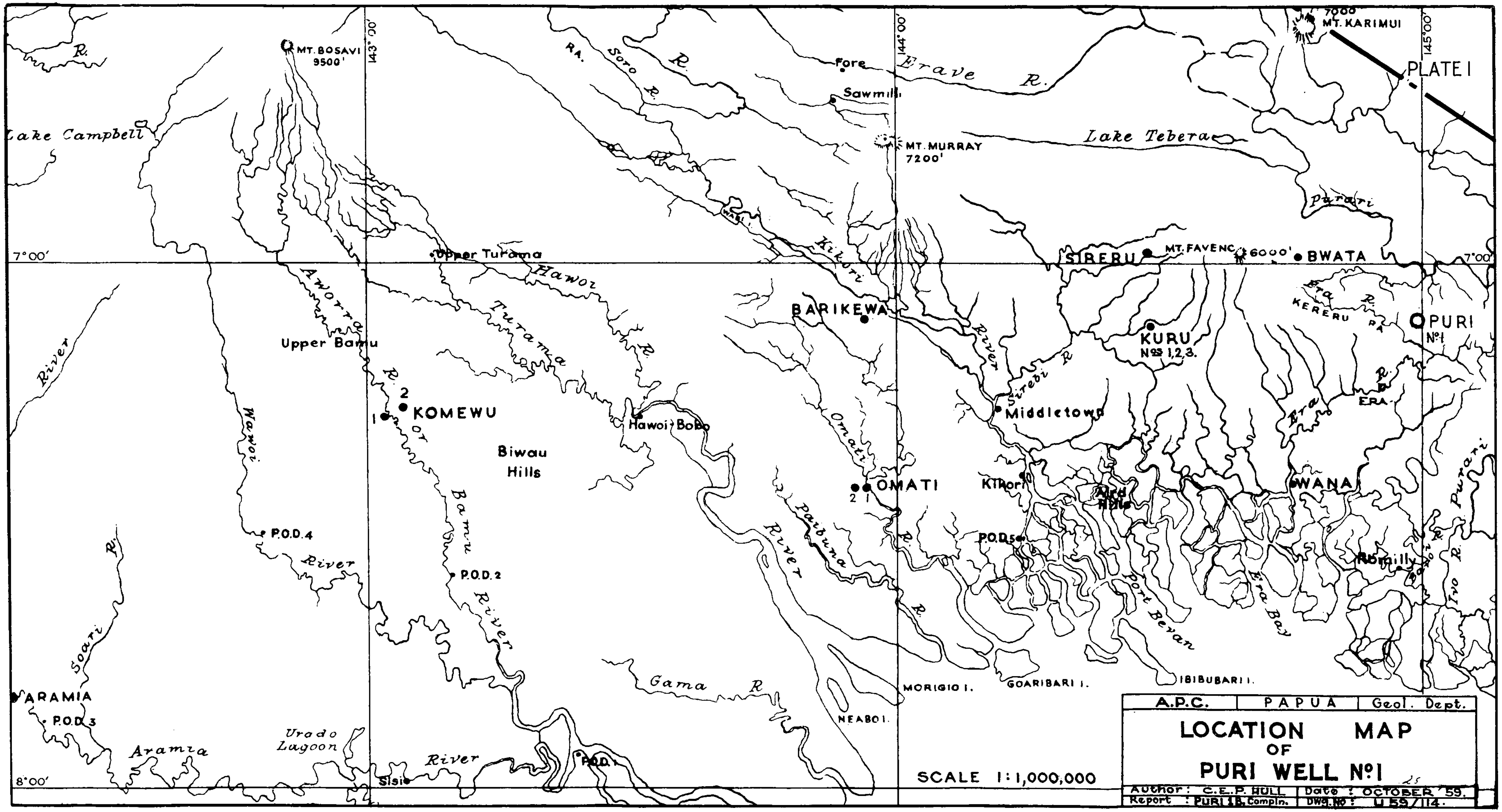
KAC : Report on the Kereru-Puri Survey -- R.E. Linton et al., 1957

LPE : Geological survey of the Puri-Kuku Area -- G.A.V. Stanley, 1952

LPA : Interim report on the Puri Anticline -- S.W. Carey, 1940

LS : Report on seismic refraction survey in the Puri-Mena Area -- T.C. Richards, 1949, with comments by L.P. Bliaux.

-10

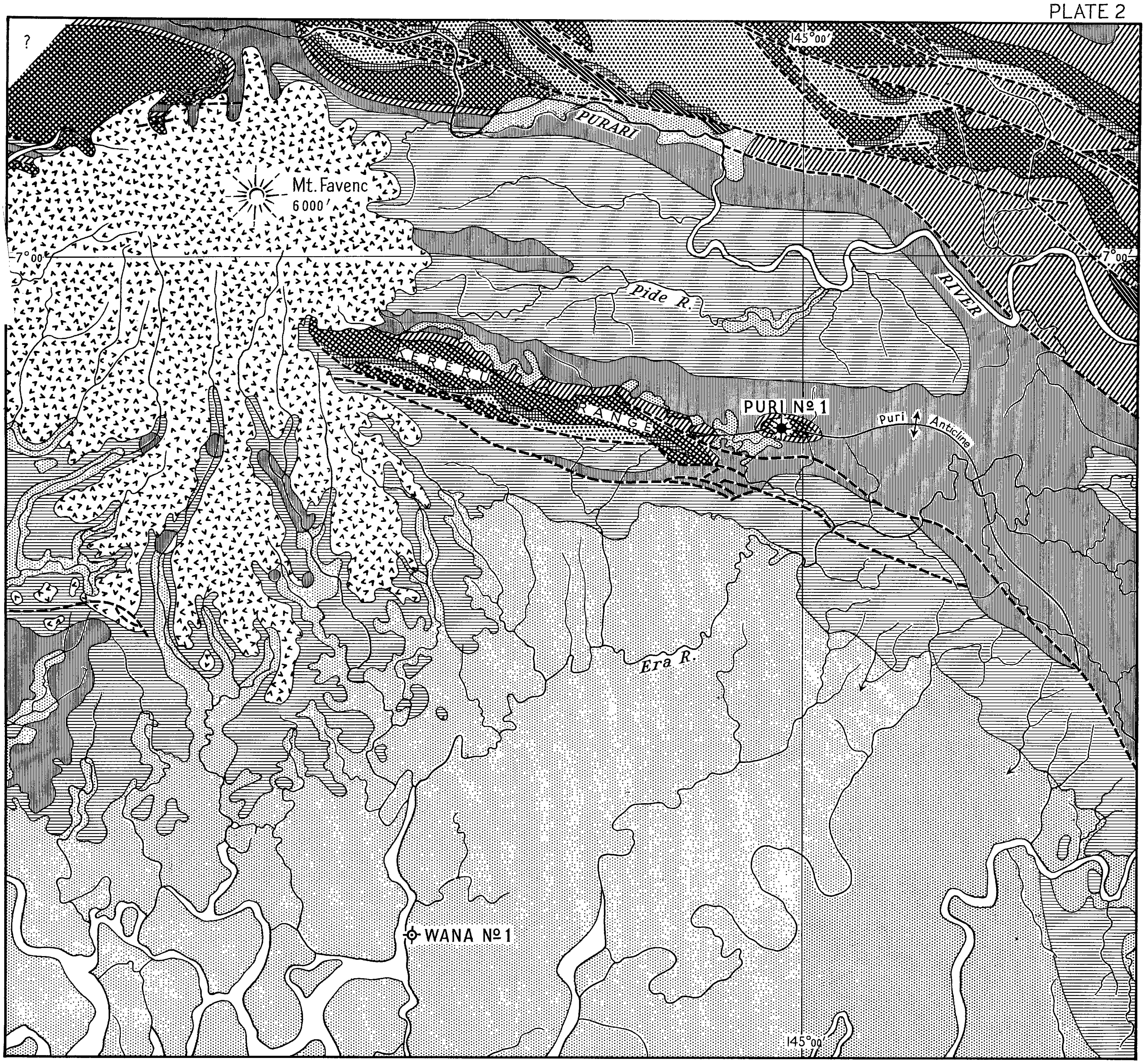


A.P.C.	PAPUA	Geol. Dept.

LOCATION MAP
OF
PURI WELL Nº1

Author : C.E.P. HULL | Date : OCTOBER '59.
Report : PURI 1B. Compln. | DWG.NO : U 59/114.

PLATE 2



REGIONAL GEOLOGICAL MAP

PURI AREA

5 0 5 10 15 20 Kilometres

5 0 5 10 Miles

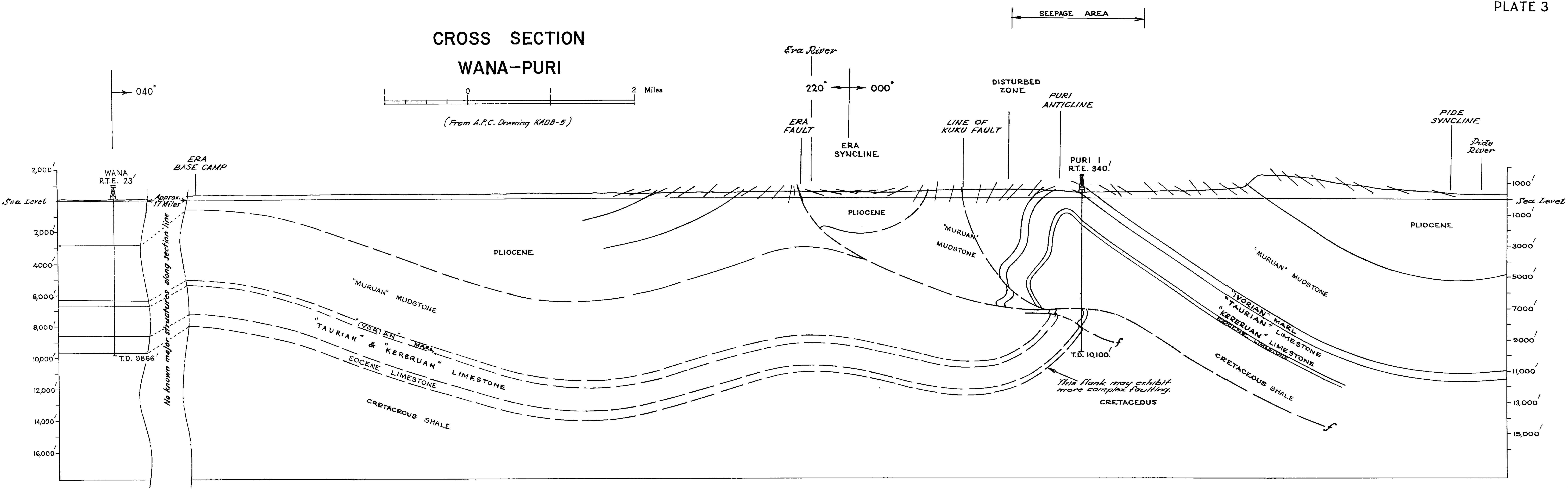
- ▒ RECENT
- ▒ PLEISTOCENE
- ▤ PLIOCENE
- ▥ UPPER MIOCENE
- ▨ MIDDLE MIOCENE
- * ▧ MIDDLE MIOCENE TO UPPER OLIGOCENE
- ▩ LOWER MIOCENE TO UPPER OLIGOCENE
- ▦ EOCENE
- ▒ CRETACEOUS

* Used where finer subdivision not practicable at this scale.

PNG 1Y-5
MK/PB

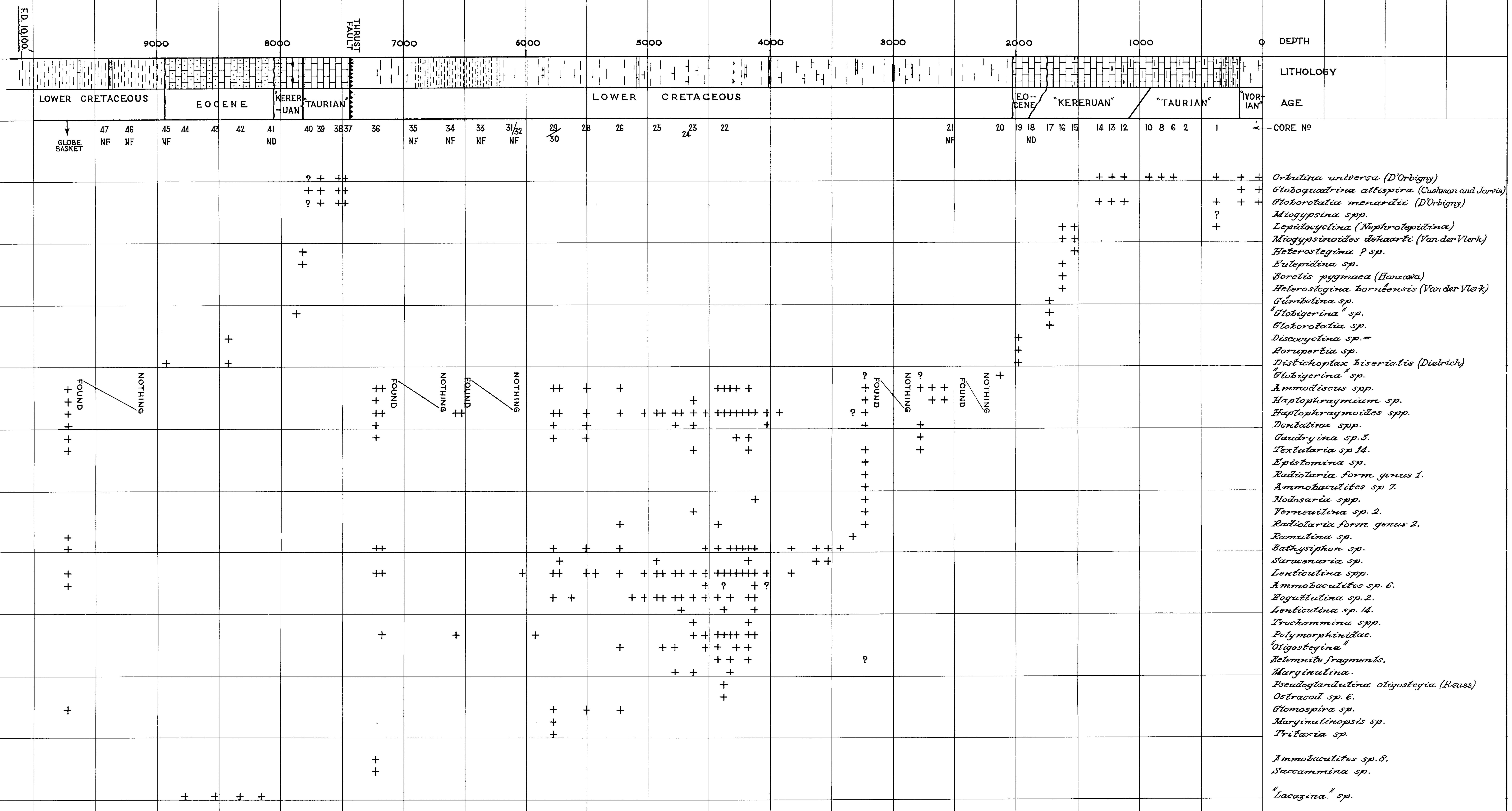
PLATE 3

CROSS SECTION
WANA–PURI



(From A.P.C. Drawing KADB-5)

PLATE 4



A.P.C. PTY. LTD.	PAPUA	GEOLOGICAL DEPT. PORT MORESBY.

DISTRIBUTION
OF THE MORE SIGNIFICANT MICRO – FAUNA IN PURI Nº I WELL

AUTHOR : F.C. DILLEY.	DATE : SEPTEMBER, 1958.
REPORT : PURI COMPLETION.	DWG. Nº : P.M. 1958/122.

Plate 5
Sheet 1

AUSTRALASIAN PETROLEUM COMPANY PTY LTD

COMPOSITE WELL LOG

PURI No 1

PAPUA
SCALE 1" : 100'

R.T.E. : 340'
Latitude : 07° 06' 24"S
Longitude : 144° 59' 56"E
CASING : 18 5/8" Shoe set at 506' (Parted Shoe at 671')
13 3/8" " " " 2099'
9 5/8" 6880' Liners:- 7": 6805'-7450' 5": 7389'-8200'
FINAL DEPTH : 10,100'
ABBREVIATION : PU.1

SPUDDED : 29·10·1957
COMPLETED : 7·8·1958
OUTFIT : National 50 Lee C Moore 132' Jack-knife

- Silt or siltstone
- Sandy siltstone or silty sandstone
- Breccia
- Marl
- Limestone
- Argillaceous limestone
- Chert

Author : C.E.P. HULL

DESCRIPTION OF SAMPLES

"IVORIAN" Marl grey marl with pelagic foraminifera, becoming more limy downwards and grading to:-

"TAURIAN" Limestone (boundary transitional) grey argillaceous limestone with abundant pelagic foraminifera

Pyritic at base
No circulation
Limestone - grey argillaceous

No circulation

Limestone - argillaceous, grey, grades downwards to marly grey-white very finely crystalline limestone

No circulation

Limestone - white to cream slightly marly, vuggy in part, grey & shaly in basal 2'

No circulation

Limestone - brownish grey hard, dense fractured, slightly argillaceous Globigerina

No circulation

Limestone - grey slightly argillaceous, dense, hard, fractures infilled with calcite. Globigerina

No circulation

Limestone - grey, hard, finely crystalline Globigerina

No circulation

Limestone - grey, hard, finely crystalline to dense, slightly argillaceous Globigerina

No circulation

Limestone - grey, hard, slightly argillaceous, slightly distorted, occasional chert nodules Globigerina

No circulation

Limestone - fractured, hard, grey, occasional chert nodules Globigerina

No circulation

Limestone - fractured, hard, grey, small pyrite nodules Globigerina

No circulation

Top of "KERERUAN" (E. Log)
1506' Limestone - light grey medium to finely crystalline, frequent stylolites, occasional chert Lepidocyclina

No circulation

Limestone - grey brown to brownish white medium to finely crystalline to dense, stylolitic Lepidocyclina Eulepidina

No circulation

Limestone - brownish grey, finely crystalline, shaly partings Globigerina (small spp.)
1762' Top of EOCENE (E. Log)
(Assumed unconformity)

No circulation

Limestone - finely crystalline granular, recrystallised silty, stylolitic, light olive grey Globigerina (small spp.)

No circulation

Limestone - med-f. crystalline recrystd.

2022' Top of CRETACEOUS (E. Log)
(Assumed unconformity)

No circulation

Dark grey, silty, slightly shaly mudstone, much veined and fractured

2166' Thin soft argillaceous silt.
Slightly calcareous 2178'-2206'

2246' Shale, dark grey, silty in part.

Bulk of samples returned as soft sludge, thought to be shale or shaly m'stone
2355'

2376' 2390' Stringers of soft orange mudstone
2398' Dark grey silty mudstone occasional stringers of siltstone, scattered calcite veining and inclusions, generally micro-pyritic. Considerable sludge returned in samples.

2650' Thin band coarse, silty, dark-grey mudstone. Dark grey silty mudstone.

2711' Thin band speckled calcareous siltstone

2764' Thin stringer orange-yellow soft mudstone

2845' Stringer (inclusion?) dense, buff limestone

2895' Siltstone, green, grey, black speckled,
2908' slightly calcareous.
Dark grey silty mudstone

2999' Stringer (inclusion?) dense buff to brown, limestone

3074' Mudstone, shaly, dark-grey, fractured, silty in part.

3274' Stringers of dense, buff to brown
3284' limestone.
Mudstone, silty in part, somewhat shaly, dark grey, scattered calcite veining

3478' 3494' Marked fracture zone.

REMARKS

Spudded in $17\frac{1}{2}$" bit
Acid solubility 20'-30' 57%

Acid solubility 170'-180' 63.4%

211' Schlumberger log shows 18 5/8" casing parted

353' Lost circulation, heavy aromatic oil in sample

408' Bailing Test, produced fresh water (10 ppm) Skimmings from surface of water gave some fluorescence as oil at 353'.

510' 18 5/8" casing originally set
534' Lost circulation. Drilling carried out with no returns to 2110'

Core No. 2 (610'-620')
610' Core fluoresced & gave amber cut in solvent. Dip 25°. Acid solubility 86% at 612'

671' Schlumberger log shows 18 5/8" shoe, after casing had parted and slipped
Cores No. 3, 4, 5, 6 (701'-738')
730' Dip 20°. Acid solubility 85%
758' Stuck pipe when opening $12\frac{1}{2}$" hole to $17\frac{1}{2}$"

Cores No. 7, 8, 9 (808'-837')
820' Dip 25°. Acid solubility 72.2%

Dip not ascertainable. Acid solubility. 79%
Core No. 10 (925'-930')

Core No. 11 (1023'-1028') Acid solubility 78%

Core No. 12 (1131'-1146')
1131' Twist off while drilling, Dip appx. 25°.
1145' Pipe stuck while opening $12\frac{1}{2}$" to $17\frac{1}{2}$" Acid sol. 79%

Core No. 13 (1225'-1240')
1226' Dip not ascertainable Acid solubility 81.3%
1240' Acid solubility 96%

1254'-1269' Rapid penetration
1260'-1266' Bit took no weight

1334' Twist off while drilling $12\frac{1}{2}$", Dip 25°-30°
Core No. 14 (1334'-1350') Acid solubility 95.7%

1437' Twist off while drilling $12\frac{1}{2}$"

Core No. 15 (1518'-1529')
Dip not ascertainable. Acid solubility 98.6%

1574' Twist off while opening $12\frac{1}{2}$" to $17\frac{1}{2}$"

Core No. 16 (1630'-1647')
Dip not ascertainable. Acid Solubility 99.8%

Core No. 17 (1743'-1748')
Dip 45° Acid solubility 91.99%

Core No. 18 (1855'-1865')
Dip 45° Acid solubility 98.45%
1873' Twist off while drilling $12\frac{1}{2}$"

Core No. 19 (1975'-1985')
Dip 40° Core below 1981' fluoresced and gave light amber cut with solvent. Acid solubility 99.86%. Twist off while opening $12\frac{1}{2}$" to $17\frac{1}{2}$"

2099' 13 3/8" Casing Shoe set
Core No. 20 (2100'-2110')
Dip not ascertainable. Drilled ahead with 12 1/4" bit and 1.5 S.G. saturated brine mud.
Junk caused trouble after drilling out shoe.

Core No. 21 (2508'-2515')
Dip 45°. Fractured at right angles to dip

Below 3300' minor but persistent caving and contamination of samples occurred.

PLATE 5
SHEET 2

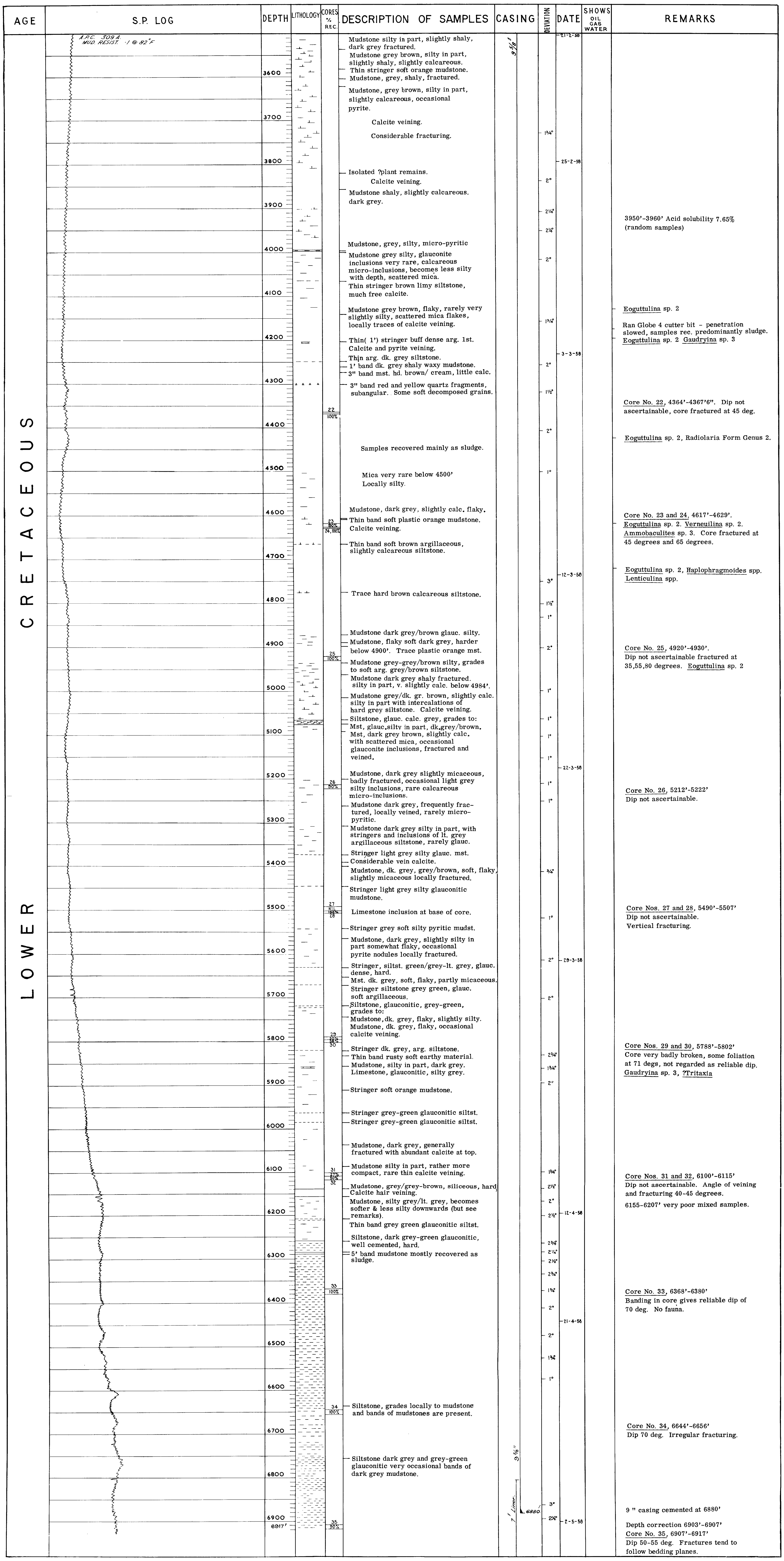
AUSTRALASIAN PETROLEUM COMPANY PTY. LTD

COMPOSITE WELL LOG

PURI No. 1

PAPUA

SCALE :- 1" — 100'



Mudstone silty in part, slightly shaly, dark grey fractured.

Mudstone grey brown, silty in part, slightly shaly, slightly calcareous.

Thin stringer soft orange mudstone.

Mudstone, grey, shaly, fractured.

Mudstone, grey brown, silty in part, slightly calcareous, occasional pyrite.

Calcite veining.

Considerable fracturing.

Isolated ?plant remains.

Calcite veining.

Mudstone shaly, slightly calcareous. dark grey.

Mudstone, grey, silty, micro-pyritic

Mudstone grey silty, glauconite inclusions very rare, calcareous micro-inclusions, becomes less silty with depth, scattered mica.

Thin stringer brown limy siltstone, much free calcite.

Mudstone grey brown, flaky, rarely very slightly silty, scattered mica flakes, locally traces of calcite veining.

Thin(1') stringer buff dense arg. 1st.

Calcite and pyrite veining.

Thin arg. dk. grey siltstone.

1' band dk. grey shaly waxy mudstone.

3" band mst. hd. brown/ cream, little calc.

3" band red and yellow quartz fragments, subangular. Some soft decomposed grains.

Samples recovered mainly as sludge.

Mica very rare below 4500'

Locally silty.

Mudstone, dark grey, slightly calc. flaky.

Thin band soft plastic orange mudstone.

Calcite veining.

Thin band soft brown argillaceous, slightly calcareous siltstone.

Trace hard brown calcareous siltstone.

Mudstone dark grey/brown glauc. silty.

Mudstone, flaky soft dark grey, harder below 4900'. Trace plastic orange mst.

Mudstone grey-grey/brown silty, grades to soft arg. grey/brown siltstone.

Mudstone dark grey shaly fractured. silty in part, v. slightly calc. below 4984'.

Mudstone grey/dk. gr. brown, slightly calc. silty in part with intercalations of hard grey siltstone. Calcite veining.

Siltstone, glauc. calc. grey, grades to:

Mst, glauc.silty in part, dk.grey/brown.

Mst, dark grey brown, slightly calc. with scattered mica, occasional glauconite inclusions, fractured and veined.

Mudstone, dark grey slightly micaceous, badly fractured, occasional light grey silty inclusions, rare calcareous micro-inclusions.

Mudstone dark grey, frequently fractured, locally veined, rarely micro-pyritic.

Mudstone dark grey silty in part, with stringers and inclusions of lt. grey argillaceous siltstone, rarely glauc.

Stringer light grey silty glauc. mst.

Considerable vein calcite.

Mudstone, dk. grey, grey/brown, soft, flaky, slightly micaceous locally fractured.

Stringer light grey silty glauconitic mudstone.

Limestone inclusion at base of core.

Stringer grey soft silty pyritic mudst.

Mudstone, dark grey, slightly silty in part somewhat flaky, occasional pyrite nodules locally fractured.

Stringer, siltst. green/grey-lt. grey, glauc. dense, hard.

Mst. dk. grey, soft, flaky, partly micaceous.

Stringer siltstone grey green, glauc. soft argillaceous.

Siltstone, glauconitic, grey-green, grades to:

Mudstone, dk. grey, flaky, slightly silty.

Mudstone, dk. grey, flaky, occasional calcite veining.

Stringer dk. grey, arg. siltstone.

Thin band rusty soft earthy material.

Mudstone, silty in part, dark grey.

Limestone, glauconitic, silty grey.

Stringer soft orange mudstone.

Stringer grey-green glauconitic siltst.

Stringer grey-green glauconitic siltst.

Mudstone, dark grey, generally fractured with abundant calcite at top.

Mudstone silty in part, rather more compact, rare thin calcite veining.

Mudstone, grey/grey-brown, siliceous, hard,

Calcite hair veining.

Mudstone, silty grey/lt. grey, becomes softer & less silty downwards (but see remarks).

Thin band grey green glauconitic siltst.

Siltstone, dark grey-green glauconitic, well cemented, hard.

5' band mudstone mostly recovered as sludge.

Siltstone, grades locally to mudstone and bands of mudstones are present.

Siltstone dark grey and grey-green glauconitic very occasional bands of dark grey mudstone.

3950'-3960' Acid solubility 7.65%
(random samples)

Eoguttulina sp. 2

Ran Globe 4 cutter bit - penetration slowed, samples rec. predominantly sludge.
Eoguttulina sp. 2 Gaudryina sp. 3

Core No. 22, 4364'-4367'6". Dip not ascertainable, core fractured at 45 deg.

Eoguttulina sp. 2, Radiolaria Form Genus 2.

Core No. 23 and 24, 4617'-4629'.
Eoguttulina sp. 2. Verneuilina sp. 2.
Ammobaculites sp. 3. Core fractured at 45 degrees and 65 degrees.

Eoguttulina sp. 2, Haplophragmoides spp.
Lenticulina spp.

Core No. 25, 4920'-4930'.
Dip not ascertainable fractured at 35,55,80 degrees. Eoguttulina sp. 2

Core No. 26, 5212'-5222'
Dip not ascertainable.

Core Nos. 27 and 28, 5490'-5507'
Dip not ascertainable.
Vertical fracturing.

Core Nos. 29 and 30, 5788'-5802'
Core very badly broken, some foliation at 71 degs, not regarded as reliable dip.
Gaudryina sp. 3, ?Tritaxia

Core Nos. 31 and 32, 6100'-6115'
Dip not ascertainable. Angle of veining and fracturing 40-45 degrees.

6155-6207' very poor mixed samples.

Core No. 33, 6368'-6380'
Banding in core gives reliable dip of 70 deg. No fauna.

Core No. 34, 6644'-6656'
Dip 70 deg. Irregular fracturing.

9 " casing cemented at 6880'

Depth correction 6903'-6907'
Core No. 35, 6907'-6917'
Dip 50-55 deg. Fractures tend to follow bedding planes.

PLATE 5
SHEET 3

AUSTRALASIAN PETROLEUM COMPANY PTY. LTD.

COMPOSITE WELL LOG

PURI No. 1

PAPUA

SCALE :— 1″ = 100′

DESCRIPTION OF SAMPLES

Siltst. dk. grey locally grey-green, glauc. w. interbed mudstone, the mst increasing with depth.

Below 7060′ the mst predominates & becomes soft & flaky, locally micaceous. Rare calc. veining, occ. interbedded and intermingled silty sections.

Trace rusty brown ferric material.

Rare calcareous inclusions.

Mudstone dark grey flaky soft.

"TAURIAN" limestone (repeated)-7425′-Thrust fault
Limestone grey-br. & brown, considerable calcite at top. Globigerina small spp. Slightly marly, tight, fractured.

Limestone grey brown slightly marly dense-v.f.cryst. Minor fracturing, rare micro-pyrite. Tight. Considerable quantities of white creamy sludge recovered in samples. Cuttings generally small.

Globigerina
Globorotalia
Buliminids

Abundant Globigerina spp

7687′
Lst. grey & buff chalky in part, dense-finely crystalline, locally platy, tight.

7746′
Lst. lt-brown & buff to grey-white finely crystall. shale partings, tight.

"KERERUAN" limestone 7788′
Chalky in part below 7788′, possibly due to grinding action of bit.

Light brown finely crystalline
specks of glauconite below 7868′.
Chert nodules 7889′-7905′.

7905′
Lst. cream to buff & lt. brown finely crystalline to dense, locally specks of ?glauconite.

7987′
Limestone grey and light grey finely crystalline sandy, speckled with glauconite, and with intercalations of dark grey shale.

EOCENE 8036′.
Limestone cream to white dense chalky in part (possibly due to bit action).

8106′.
Limestone sandy glauconitic. Cuttings recovered as mostly creamy sludge but it is inferred that dense platy limestone is interbedded with thin streaks of sandy glauconitic limestone.

Appears recrystallised.

8418′
Limestone, recovered as white chalky sludge. Solid cuttings are cream-white fossiliferous finely crystalline limestone.

8504′
Limestone cream to white, fractured, vuggy, recrystallised shaly stylolitic partings with trace of glauconite and subrounded sand grains.

Appears generally less sandy below 8890′. Recycled cuttings recovered as white chalky sludge.

8928′
Siltstone dark grey green glauconitic, fine subangular quartz grains in slightly argillaceous mainly siliceous matrix. Barren.

9160′
Cuttings suggest thin interbeds of dark grey shale, silty and glauconitic in part; (possibility of contamination from above 7425′)

9230′
Siltstone, dark grey and grey green, glauconitic.

9355′
Laterolog shows bands or large inclusions of white silty limestone (faulted sections of Eocene).

9389′

9503′)
9521′) Porous bands in siltstone (Schlumberger)
9545′)

9624′) Limestone white recrystallised silty, much
9632′) recovered as white pug. (Faulted sections of Eocene)

9708′
Siltstone dark grey green glauconitic with interbedded mudstone.

10,100′ Total depth.

REMARKS

Core No. 35, 6907′-6917′
Dip 55-60 deg.

Core No. 36, 7217′-7229′.
Dip 55 deg.

Core No. 37, 7459′-7471′ Dip 45 deg.
Acid solub. 86.1%
Samples 7483′-7503′ amber cut w.cold solvent.
7504′ Lost circ.@ 160 cu ft/hr. Total Loss 100 cu ft.

Core No. 38, 7518′-7529′. Dip 45 deg.
Negative oil show. Acid sol. 85.9%

7577′-7621′ Acid solubility 81.1%

Samples 7746′-7758′ good amber cut with cold solvent. Sidewall cores cut 7730′-7760′. Poor recovery. No oil indications.

Core No. 39, 7662′-7674′. Dip 70 deg.
Acid solubility 82.7%

7992′ Acid solubility 68.1%
Sidewall cores cut 8040′-8060′
No oil indications. Poor recovery.
Core No. 41, 8067′-8079′. Dip 50 deg.
Acid solubility 99.9%
Core No. 40, 7758′-7768′. Dip 50 deg.
Negative oil show. Acid sol. 94.1%.
Samples 7816′-7824′ gave positive cut - regarded as contamination from rig lubricant.

Core No. 42, 8378′-8388. Dip 60 deg.
Acid solubility 99.74%

Total loss of circulation at 8504′-loss 2100 cu ft.
Core No. 43, 8504′-8509′. Dip 45 deg.
Acid solub. 93.65%. Open fractures at right angles to dip.
8509′-9418′ Cuttings and sawdust recycled - samples very poor.

Core No. 44, 8782′-8788′. Dip 65 deg.
Acid solubility 95.63%. Slight irregular open fracturing.

Core No. 45, 8948′-8958′. Dip 50 deg.

Ran Electric Log.

Core No. 46, 9246′-9256′. Dip 54 deg.

Cuttings 9370′-9408′ contained up to 50% white silty limestone.
Drilled 9418′-9434′ without recycling cuttings but lost circulation at 9434′ presumably to upper hole.
Drilled 9434′-9959′ recycling cuttings.
Core No. 47, 9408′-9418′. Dip 50 deg.

Cuttings 9622′-9640′ contained 40% limestone and drilling speed increased locally.
9662′ lost circulation.

9717′ Fishing Job, Bit Cutter.
Globe Basket recovered typical Cretaceous shale

Drilled 9959′ T.D. without recycling cuttings.

Ran Electric log, Laterolog, Micro-Caliper log, Gamma Ray/ Neutron log and Sidewall Cores.

Drawing N° : P.M. 58/120