COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

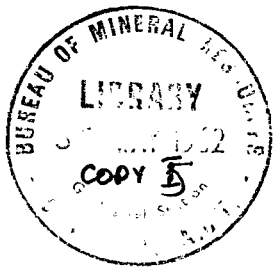
PETROLEUM SEARCH SUBSIDY ACTS

Publication No. 9

INNAMINCKA No. 1 WELL, SOUTH AUSTRALIA

OF

DELHI-FROME-SANTOS



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

2764/61.

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 Section.

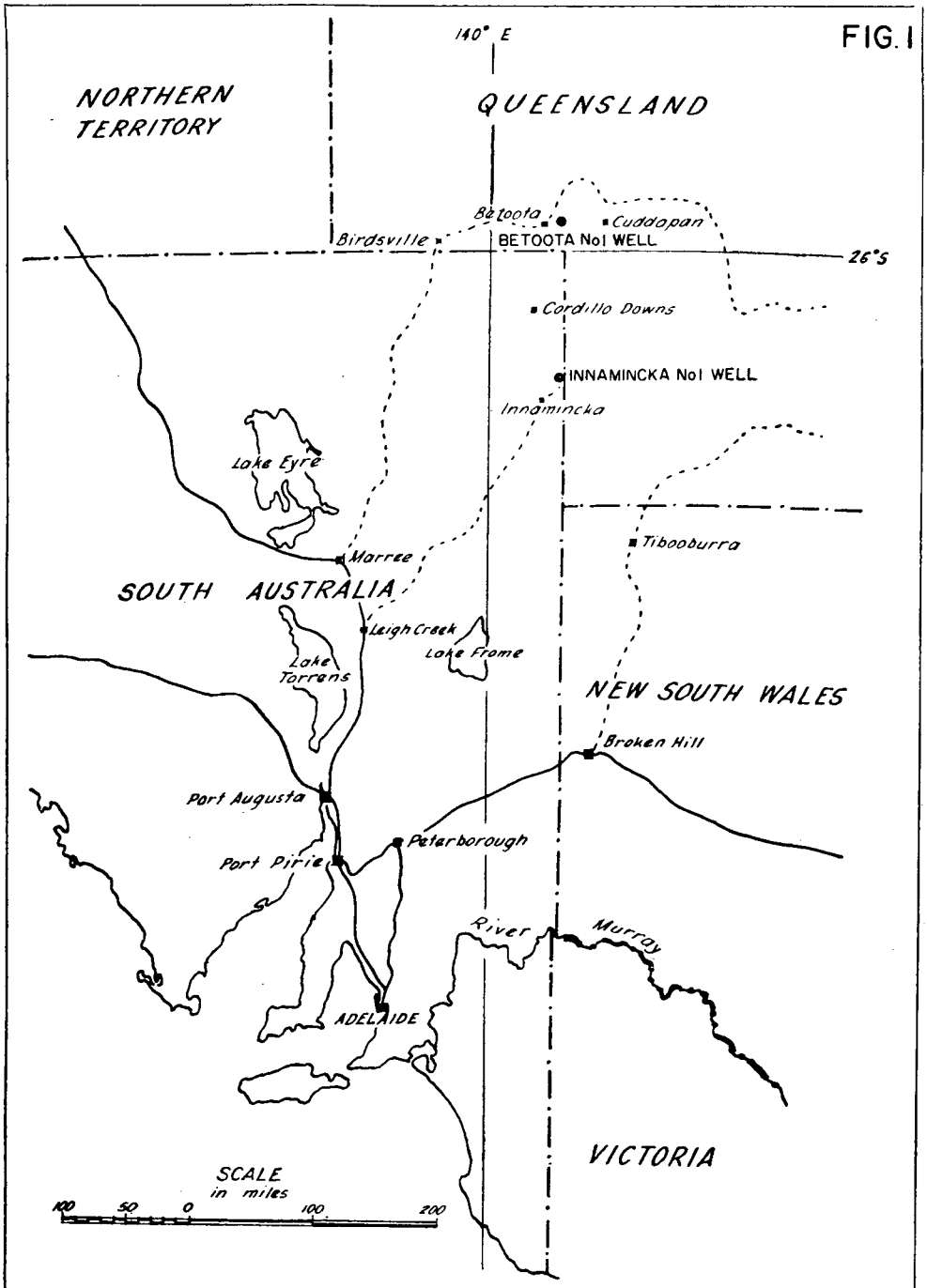
Chief Geologist : N. H. FISHER.

CONTENTS.

ILLUSTRATIONS.

PLATES.

FIG. 1



LOCALITY MAP

BETOOTA No1 WELL AND INNAMINCKA No1 WELL

WELL COMPLETION REPORT

BY

JOHN C. RYAN.*

* Exploration Supervisor, Delhi Australian Petroleum Ltd.

SUMMARY.

The Innamincka No. 1 test well, drilled by Delhi Australian Petroleum Ltd, Frome-Broken Hill Company Pty Ltd, and Santos Limited, in the north-east corner of South Australia, penetrated the strata below the surface in the deeper portion of the Great Australian Artesian Basin to a total depth of 12,637 feet. The test was begun late in March, 1959, using a National 130 drilling rig operated by Delta Drilling Company. The operation, under supervision of drilling, engineering, and geological personnel of Delhi Australian Petroleum Ltd, involved an extensive programme to obtain technical data relative to the occurrence of hydrocarbons in the strata cut by the drill bit, as well as stratigraphical information concerning the geological history of the area. Included in the operation was a full complement of logging, coring, and testing programmes provided and conducted by the operating Company and their Contractors.

Innamincka No. 1 established the presence of at least 6,723 feet of Mesozoic sediments, as well as 5,914 feet of sediments of Palaeozoic age at the wellsite. Several minor showings of hydrocarbons were encountered within the Mesozoic sequence below 3,928 feet in non-marine sediments; however, after thorough examination and testing, the shows proved inconsequential. Several zones within the interval 4,390 feet to 7,050 feet evidenced physical qualities such that the rock could be classified as mechanically favourable as reservoir type rock, but an analysis of the sediments suggested that their origin was not favourable as hydrocarbon source rocks. The intervals 0 feet to 4,390 feet and 7,050 feet to 12,637 feet did not suggest qualities of either source-bed or reservoir type rocks.

The well was completed in late November, 1959 as an artesian water well from the Blythesdale Formation through perforations between 4,390 feet to 4,560 feet.

INTRODUCTION.

The Innamincka No. 1 test well was drilled so as to establish the potential of the sedimentary section to produce commercial quantities of hydrocarbons, either oil or gas, on an anticlinal structure in the Great Australian Artesian Basin.

The Innamincka structure was defined by surface geological mapping and seismic methods. It was established as a prominent anticlinal fold within the deeper reaches of the Artesian Basin, where a suggested sedimentary section could include many thousands of feet of strata of marine origin, particularly within sediments of Palaeozoic age. The area was vertically unexplored and untested. The relationship of a thick Marine sequence as source material and structure as a mechanical trap justified an extensive deep test bore.

WELL HISTORY.

GENERAL DATA.

Well name and number.—Innamincka No. 1.

Location.—27° 29′ 21.3″ South, 140° 55′ 07.7″ East. *See* Figure 1.

Name and address of tenement holder.—Delhi Australian Petroleum Ltd, 316 Da Costa Building, Adelaide, South Australia; Santos Limited, Mutual Life Chambers, 44 Grenfell-street, Adelaide, South Australia.

Details of petroleum tenement.—Oil Exploration Licences 20 and 21, issued by the State of South Australia.

District.—Northern.

Total depth.—12,637 feet.

Date drilling commenced.—28th March, 1959.

Date drilling completed.—16th November, 1959.

Date well completed.—27th November, 1959.

Date rig was released.—The rig was not released. Dismantling operations for the move to Betoota, Queensland, began on 28th November, 1959.

Drilling time in days to total depth.—234 days.

Elevation.—Ground, 401.68 feet a.s.l.; Rotary table, 412.68 feet.

Status of well.—Completed as an artesian water well through perforations 4,390 feet to 4,400 feet, 4,465 feet to 4,475 feet and 4,550 feet to 4,560 feet for approximately 25 barrels of water per hour or 26,400 gallons per day. Flow pressure on well head gauge was 50 p.s.i. Chloride content was estimated at 2,000 p.p.m. to 2,500 p.p.m.

On completion of the D.S.T. at 4,390 feet to 4,400 feet, the blow-out preventors were removed. The casing was cut off below the 9⅝-in. casing slips. Drill pipe was run in the hole and the mud displaced with water to a depth of 4,575 feet. The drill pipe was then laid down and the well perforated in the zones 4,550 feet to 4,560 feet and 4,465 feet to 4,475 feet with four jet shots per foot. A 5½-in. casing collar was welded to the 9⅝-in. casing. A 5½-in. to 4-in. British thread swedge was installed on the well head, and a 4-in. control valve installed, completing the well.

DRILLING DATA.

Name and address of drilling contractors.—Delta Drilling Company, Tyler, Texas, U.S.A.

Drilling plant—

Make: National "Ideal".
Type: 130.
Rated capacity with 4½-in. drill pipe: 16,000 feet.
Rated capacity with 3½-in, drill pipe: 25,000 feet.
Motors (5): Superior Type PTD6, rated 300 b.h.p. at 700 r.p.m.

Mast.—Lee C. Moore 142-ft. cantilever, ratio capacity 830,000 lb.

Pumps.—Ideal: Two Type C-350, Size 7¾ inches x 18 inches; One Type C-250, Size 7¼ inches x 15 inches.

Blow-out preventor equipment—

Shaffer Gate: Model Hydraulic Double, Size 13⅝ inches, Test Pressure 6,000 p.s.i.
Shaffer Gate: Model Hydraulic Double, Size 10 inches, Test Pressure 10,000 p.s.i.
Shaffer Gate (2): Model Single " 34 ", Size 18 inches, Test Pressure 4,000 p.s.i.
Hydril: Model GK12 Series 900, Size 13⅝ inches, Test Pressure 6,000 p.s.i.
Hydril: Model GK10 Series 1500, Size 11 inches, Test Pressure 10,000 p.s.i.

Hole sizes and depths—

(1) 27-in. hole to 231 feet—
  (i) Drilled 12¼-in. hole to 231 feet.
  (ii) Reamed with hole opener to 27 inches to 231 feet.
  (iii) Set 20-in. conductor pipe to 231 feet.

(2) 17½-in. hole to 4,021 feet—
  (i) Drilled 12¼-in. hole to 1,025 feet.
  (ii) At TD 1,025 feet reamed to 17½-in. hole to 610 feet.
  (iii) Drilled 12¼-in. hole to 2,064 feet.
  (iv) At TD 2,064 feet reamed to 17½-in. hole.
  (v) Drilled 12¼-in. hole to 4,048 feet.
  (vi) At TD 4,048 feet reamed to 17½-in. hole to 4,021 feet.
  (vii) Set 13⅜-in. intermediate casing to 4,017.68 feet.

(3) 12¼-in. hole to 7,935 feet—
  (i) Set 9⅝-in. casing to 7,935 feet.

(4) 8½-in. hole to 12,637 feet.

Casing and Liner details—

Size: 20-in. conductor.
Weight: 94 lb./ft.
Grade: H40.
Range: 1.
Setting depth: 228 feet.

Size: 13⅜ inches.
Weight: 54.50 lb./ft.
Grade: J55.
Range: 1, 2 and 3.
Setting depth: 4,017.68 feet.

Size: 9⅝ inches.
Weight: 43.50 lb./ft.
Grade: N80.
Range: 2 and 3.
Setting depth: 7,935 feet.

Casing and Liner cementing details—

Size: 20 inches.
Setting depth: 228 feet.
Quantity cement used: 400 sacks.
Cemented to: Surface.
Method used: Circulated to surface with a single Howco T10 pumper.

Size: 13⅜ inches.
Setting depth: 4,017.68 feet.
Quantity cement used: 3,250 sacks.
Cemented to: Surface.
Method used: 2 stage with 1,750 sacks on first stage and 1,500 sacks on second stage. The float collar was at 3,981 feet and the DV tool at 2,030 feet. The cement was mixed and pumped with a single Howco T10 pumper. Ran 8 Howco centralisers.

Size: 9⅝ inches.
Setting depth: 7,935 feet.
Quantity cement used: 2,000 sacks cement and 820 gallons cement retarder.
Cemented to: 4,180 feet (approximately).
Method used: Cement mixed and pumped with a single Howco T10 pumper. Ran 8 Howco centralisers and 10 Howco scratchers.

Drilling Fluid.—Drilling fluid was a water-base chemical mud, using bentonite, myrtan, gel, and caustic. Average weight was approximately 9.9 lb. per gallon to 5,000 feet; 10.3 to 6,600 feet; 10.4 to 9,900 feet; and 10.5 to total depth 12,637 feet.

Treatment of the mud varied with depth, with progressive consideration given to bottom-hole temperature affecting mud control. To TD 6,600 feet the drilling fluid was essentially a natural mud, with very small daily treatments of myrtan and magcophos. A typical daily treatment from 6,600 feet to TD would be 10 sacks of gel, 350 lb. of myrtan, 125 lb. of caustic soda, and approximately 40 barrels of water.

An analysis of the mud was made every day, often each tour. An average weekly analysis to 5,000 feet was: mud weight 9.9 lb. per gallon, viscosity (Marsh) 46 sec., and water loss 16 cc./30 min. An average weekly analysis 5,000 feet to 6,600 feet was: mud weight 10.3, viscosity 50. water loss 12. Average weekly analysis 6,600 feet to 9,900 feet was: mud weight 10.4, viscosity 48, water loss 11. Average weekly analysis 9,900 feet to total depth 12,637 feet was: mud weight 10.5, viscosity 54, water loss 15.

Water Supply.—Water supply for the drilling of the Innamincka No. 1 was from shallow wells (500 feet to 600 feet) about 12 miles from the well site. Water wells were drilled by Geosurveys of Australia Limited under supervision of a Delhi Australian Petroleum Ltd engineer; water analysis was conducted by the Research and Development Branch of the South Australian Department of Mines. Chloride count of the drilling water was 156.6 grains per gallon (2,232 p.p.m.).

Water from the shallow bores was stored in open-air natural creek pits and then piped to location through 12 miles of 4-in. Class " B " Victaulic piping with shouldered ends.

Perforation and shooting record.—Casing Perforation:

(1) 6,810 feet to 6,820 feet.
6,830 feet to 6,850 feet.
6,855 feet to 6,865 feet.
6,875 feet to 6,895 feet.
(2) 5,495 feet to 5,515 feet.
(3) 5,040 feet to 5,050 feet.
(4) 4,775 feet to 4,795 feet.
(5) 4,390 feet to 4,400 feet.
(6) 4,465 feet to 4,475 feet.
4,550 feet to 4,560 feet.

Perforated with Welex 5-in. gun at four jet shots per foot. Shots are Welex " Dynajets " making a 0.59-in. hole with a penetration of 11.9 inches on A.P.I. tests. The gun was 10 feet long, the shots spaced spirally on 120°. Weight of shot explosives was 34 grams.

Open Hole Shooting: None.

Plugging Back and Squeeze Cementation Jobs.—At TD 12,637 feet:

(*a*) Set 100-sack cement plug from 8,050 feet to 7,780 feet. Set for 12 hours, tested and failed to find plug.

(*b*) Set 65-sack cement plug from 7,837 feet to 7,995 feet. Set 12 hours. Found top of plug at 7,815 feet. Tested plug with 15,000 lb. weight with pump running. Pressured up casing with 1,200 p.s.i. Plug held.

(*c*) Set 100-sack cement plug from 6,635 to 6,900 feet. Set for 12 hours. Found top of plug at 6,600 feet. Tested plug with weight and pump running. Pressured casing to 1,000 p.s.i. Plug held.

(*d*) Set 50-sack cement plug from 5,525 feet to 5,390 feet. Set for 12 hours. Found top of plug at 5,388 feet. Tested plug with 30,000 lb. weight and pump running. Pressured up casing to 1,200 p.s.i. Plug held.

(*e*) Set 50-sack cement plug from 5,055 feet to 4,920 feet. Set for 11 hours. Found top of plug at 4,925 feet. Tested plug with 30,000 lb. weight with pump running. Pressured casing to 1,000 p.s.i. Plug held.

(*f*) Set 50-sack cement plug from 4,800 feet to 4,665 feet. Set for 12 hours. Found top of plug at 4,700 feet. Tested plug with 30,000 pounds weight with pump running. Pressured up casing with 1,000 p.s.i. Plug held.

Fishing Operations—

(1) *Total depth* 7,464 *feet.*—Attempted to come out of hole with Bit No. 39 12¼-in, OSQ. Left Totco and three 8-in. drill collars in hole. Went in with overshot. Caught fish, pulled up to 4,500 feet, lost fish, which fell to bottom. Redressed overshot with smaller grapple. Caught fish and recovered Totco and all drill collars. Left three 12¼-in. OSQ-2 cones in hole. Conditioned hole. Attempts to recover cones with 10¾-in. junk basket, 11½-in. overshot, and 12-in. and 11¼-in. junk baskets failed. Milled with 12¼-in. Kinzbach Type K mill. Recovered one pint bearings and pieces of bearing races

with Reed junk basket. Recovered additional one quart bearings and junk with tapered point wall hook type rig-made tool and Reed junk basket. Went in with Globe junk basket with magnet, recovering bearings and junk. Went in hole with tapered point wall hook tool to centre junk: re-ran Globe junk basket and magnet and recovered cone No. 2. Re-ran Globe junk basket and magnet and recovered cone No. 3. Fish completely recovered.

(2) *Total depth* 7,881 *feet.*—Pulled out of hole with Bit No. 48, 12¼-in. Reed " T ". Left 8 drill collars in hole. Went in hole with 11-in. Bowen overshot. Recovered fish.

(3) *Total depth* 7,915 *feet.*—Twisted off while drilling; left 5 drill collars in hole. Went in with Bowen overshot. Recovered fish.

(4) *Total depth* 7,933 *feet.*—Stuck Welex sidewall core gun at bottom of 13⅜-in. casing while coming out of hole. Went in hole with side overshot. Recovered sidewall core gun.

(5) *Total depth* 7,933 *feet.*—Hung up Welex electric log tool at bottom of 13⅜-in. casing. Went in hole with rig-made side door overshot. Recovered electric log tool.

(6) *Total depth* 11,800 *feet.*—Dropped ball pean hammer in hole. Run 8¼-in. K and G magnet. Recovered hammer.

(7) *Total depth* 12,391 *feet.*—Stuck Diamond Bit No. 2 at 12,308 feet. Spotted diesel oil. Failed to free pipe. Ran free point indicator, found pipe free to bit. Backed off pipe at 11,947 feet. Ran Bowen hydraulic jars. Jarred bit loose. Recovered fish.

(8) *Total depth* 12,576 *feet.*—Stuck Hycalog core barrel going in hole. Backed off at Hycalog safety joint. Went in with Bowen jars. Recovered fish.

Side-tracked hole.—None.

LOGGING AND TESTING.

Ditch Cuttings.—Sampled at Core Laboratories, Inc. shale shaker in logging unit with direct connection to flow line. Samples collected and analysed every two (2) feet and sacked in 10 feet intervals.

Coring.—Original programme: " The coring programme will include the coring of fresh water sands, drilling breaks, and significant lithological changes, as well as oil or gas shows." " A core analysis laboratory will be available at the well site for the determination of porosity, permeability, connate water and oil saturation."

The programme was designed to gather maximum stratigraphical information, concentrating upon formation changes and reservoir and fluid information. In addition, routine stratigraphical cores would be taken, with a maximum of 500 feet between cores, as required by the Commonwealth Subsidy Act. Thirty-five (35) cores were cut for a total footage of 633 feet. 506.1 feet were recovered for a total recovery of 80 percent.

Coring equipment used consisted of both conventional and diamond coring. The softer formations were cut using " Korking " Model K500 barrels with conventional Hughes Type " J " soft and hard formation cutter heads with core-catcher assemblies.

Diameter of core recovered was 2½ inches. The hard formations (core 14, approximately 6,541 feet) were cored with Hycalog barrels, using Hycalog 8⅜-in. diamond core heads, diameter of the cores being 4⅜ inches.

See Appendix 4 for detailed description of cores.

Side-wall Sampling.—Intervals sampled:

Shot.	Depth.	Recovery.
	Feet.	
1	6,892	No recovery
2	6,675	No recovery
3	6,645	No recovery
4	6,465	No recovery
5	6,405	Very poor sample. Several small cuttings grey, fine-grained, soft sand, probably from wall cake. Sample too poor to analyse
6	6,370	No recovery
7	6,345	Very poor sample. Small piece of red, soft, sandy shale, probably from wall cake
8	5,855	No recovery
9	5,855	No recovery
10	5,537	No recovery
11	5,521	No recovery
12	5,507	No recovery
13	5,458	No recovery
14	5,446	No recovery
*15	5,398	Very poor sample. Grey, lignitic, very silty shale-siltstone
16	5,296	No recovery
17	5,275	No recovery
*18	4,818	Very poor sample. Mostly wall cake. One thin piece, probably in place, of grey, fine-grained, slightly micaceous sand, with fair fluorescence and poor cut
19	4,812	Very, very poor sample. Mass of fine grained, loosely consolidated sand, with no show. Mostly wall cake
*20	4,785	Poor sample (best sample of survey). Grey, fine-grained, loosely consolidated sand. Fair-good yellow fluorescence with good flowing cut. Good show oil
21	4,780	Very poor sample. One piece of very lignitic, micaceous, shaly siltstone, possibly from wall cake
22	4,774	No recovery
23	4,422	No recovery
24	4,418	No recovery
*25	4,412	Very poor sample. Few pieces of grey, coarse-grained, poorly sorted, loosely consolidated, quartz sand. No show
26	4,275	No recovery
27	4,270	No recovery
*28	4,265	Very poor sample. Few pieces of grey, very fine-grained lignitic, micaceous siltstone, mostly wall cake
*29	4,245	Very poor sample. Grey lignitic sandy shale. Small chips, mostly wall cake
30	..	Did not fire

* Cores marked with * were sent to Core Laboratories, Houston, Texas, for examination and analysis.

Method Used.—Welex side-wall coring gun. Analysis by Core Laboratories, Inc. laboratories in Houston, Texas, U.S.A. by Engineer Braxton.

Electrical and other Logging—

Electrical and other conventional Wireline Logging.—Wireline logging, including electrical self potential-resistivity, guard, contact-caliper, radioactivity (gamma ray-neutron), and dipmeter surveys were conducted by Welex, the wireline

service division of Halliburton Oil Well Cementing Company. Logging was done periodically as separate runs at the discretion of the Delhi supervisory geological personnel on location.

Mud Logging.—Mud logging was done by Core Laboratories, Inc., and included a complete analysis and summary of technical data concerning core and drill cutting and mud examination, physical data relative to drilling, such as rate of drill penetration, pump pressure, weight of drill string, &c., and hydrocarbon content in cuttings and drilling fluid. The unit manned by three experienced reservoir engineering geologists provided daily and weekly charts serving as reports for the above.

Drilling Time and Gas Log.—Drilling time or rate of penetration and a hydrocarbon index gas log have been included as an integral part of the "Grapholog" by Core Laboratories, Inc.

Formation Testing.—Formation testing in open hole was called for by the Delhi supervisory geological personnel on location, and was conducted by Delhi supervisory drilling personnel. The tool used was a Halliburton Hydraspring tester with a single packer, safety joint, jars, and circulating sub.

Formation testing through perforations was conducted by Delhi Australian supervisory drilling personnel after a programme submitted by Delhi Reservoir Engineering personnel.

Drill stem tests Nos. 1 and 2 were conducted in open hole concurrently with drilling operations, so as to test shows of oil or gas found in the drill cuttings and mud stream. Results indicated like zones of low permeability with little formation fluid yield and minimum formation pressure.

Drill stem tests Nos. 3 and 4 were conducted in open hole concurrently with drilling operations, so as to test shows of fresh water as indicated by the mud characteristics. The tests were conducted in badly fractured thin sand, shale, and mudstone beds and, as a result, the packer failed on both attempts. Both tests were considered mechanical failures. Because of the nature of the formations, difficulty in testing, and minimum value of the information to be secured, it was decided to forego further drill-stem test attempts in that section.

Drill stem tests 5 to 9 were conducted through perforations in the 9⅝-in. casing, using the Halliburton Hydraspring hookwall test tool with tool arrangement as with open-hole tests. The tests were designed to further evaluate certain shows of hydrocarbons, as well as certain obvious water sands. Objective was to secure maximum information concerning fluids and pressures. All tests except DST No. 5 proved to have tested water-bearing formations.

Detailed results of both open-hole and casing drill stem tests may be noted in Appendix 6.

Deviation Surveys.—Deviation surveys were conducted periodically, making use of the Totco dropped through the drill string, usually just before a trip. Average deviation to 7,330 feet showed slightly less than 1°; the balance of the hole to TD 12,637 feet showed an average deviation of between 2¾° and 3°. Only in two places did the hole deviate

more than 3¾°: 4¼° at 9,879 feet and 5½° at 12,570 feet. A list of the several Totco deviation surveys is noted below. The Welex dipmeter log also registered an angle of inclination or deviation of the hole from 7,934 feet to 12,637 feet.

Depth.	Deviation.	Depth.	Deviation.	Depth.	Deviation.
Feet.	Degrees.	Feet.	Degrees.	Feet.	Degrees.
300	½	7,834	3½	9,620	3½
485	¼	7,875	2½	9,686	3½
1,250	½	7,910	2½	9,754	3¼
1,500	0	7,932	2¾	9,820	3¼
2,015	½	7,953	1¾	9,879	4¼
2,425	1½	7,995	3½	9,960	3¾
2,730	1	8,070	3	10,000	3¾
3,000	1½	8,152	2½	10,094	3
3,120	1½	8,239	3	10,153	2¼
3,686	1¼	8,293	3	10,210	2¼
3,790	1¾	8,337	3	10,284	3½
3,937	1	8,392	2½	10,330	3½
4,319	¾	8,495	3	10,495	2½
4,529	1¼	8,531	2¼	10,525	2¾
4,948	1½	8,600	3¼	10,649	1¾
5,196	2	8,660	2¼	10,713	2¾
5,306	1	8,735	2¼	10,766	1½
5,569	1¼	8,767	3¼	10,881	1½
5,800	1½	8,832	2¾	10,950	2¼
5,926	1¼	8,888	3	11,055	2¾
6,050	1	8,910	3	11,106	3
6,300	1¼	8,946	2¾	11,140	2¾
6,382	¾	8,990	3	11,343	2
6,502	1¼	9,018	3	11,396	3
6,650	1¼	9,052	2¼	11,620	3¼
6,820	¾	9,099	3½	11,680	3¼
7,000	1¼	9,136	3¼	11,727	2½
7,100	1¼	9,186	2¾	11,795	2¾
7,330	¾	9,224	3	11,880	2¼
7,540	3¾	9,281	3	12,067	2¼
7,575	1¾	9,336	3¼	12,223	2¼
7,603	1¾	9,370	2½	12.357	3
7,704	2½	9,555	3½	12,570	5½
7,724	3¼	9,608	3½		

Temperature Surveys.—A temperature survey was run at total depth 7,935 feet on 17th July, 1959. The survey by Welex logged from TD 7,898 was run after the 9⅝-in. intermediate casing was cemented.

Bottom hole temperatures were recorded by Welex on electric log runs below 6,081 feet. They recorded maximum bottom hole temperatures as follows:—

6,081 feet	184°
7,933 feet	193°
8,670 feet	220°
10,236 feet	238°
10,712 feet	244°
11,395 feet	260°
11,618 feet	264°
12,387 feet	280°
12,635 feet	280°

Other Well Surveys.—A well velocity survey was made in the Innamincka No. 1 on 9th July, 1959, at total depth 7,935 feet. The survey was conducted by the Geophysical Section of the South Australian Department of Mines. Survey equipment included a Department of Mines Mayhew 1,000 shot-hole drill, a portable survey kit from Wapet, Perth, a cable lead and three component well geophone from G.S.I., Perth, and an O.D. and E. winch truck with a 6-conductor 12,000-ft. Schlumberger type cable.

Details concerning the survey are included in Appendix 5 as a separate report.

GEOLOGY.

Summary of Previous Work.

Geological.—The Innamincka structure was mapped during the year 1958 under the supervision of the Delhi Australian Exploration Department. Field work was done by geologists contracted from Geosurveys of Australia Limited. A geological report* was distributed to the various interested parties.

The mapping programme was essentially reconnaissance, in part consisting of the measurement and stratigraphical classification of scarp sections along the eroded limbs of the structure at selected intervals, and the measurement of dip at those points. A more detailed survey of the centre of the dome consisted of the mapping of "limestone" outcrops found in the exposed Cretaceous. Elevations were taken along the traverses and some topographic mapping was done within the confines of the escarpments.

Geophysical.—A seismic survey was conducted between August and November, 1958, on the Innamincka anticline. It consisted essentially of split correlation reflection and refraction seismic reconnaissance. The programme was conducted by the Geophysical Department of the South Australian Department of Mines, and was supervised by both the Department's supervisory personnel and Delhi Australian Exploration Department. One hundred and three holes were shot along six traverse lines totalling 165 miles. Twelve thousand four hundred and fourteen feet of hole were drilled, with an average depth of 107 feet per hole; shot holes were approximately 5,000 feet apart.

Records were interpreted and subsequent structural mapping done separately by the Geophysical Department, Delhi-Taylor Oil Corporation, Dallas, Texas†, and the Geophysical Department, South Australian Department of Mines. Horizons mapped were several zones within the Mesozoic section and also the (?)top of the Palaeozoic.

Drilling.—No prior stratigraphic drilling had been done on the Innamincka anticline.

Stratigraphy.

232 feet to 1,795 feet— 71m – 547.1m

Equivalent to Winton Formation.

Age: Mesozoic (Cretaceous: Cenomonian).

Light grey, silty, carbonaceous and grey green mudstone; grey, fine-grained siltstone, some pyritic, carbonaceous, well cemented, hard to loosely consolidated sandstone; traces of light grey, dense, hard limestone. Leached red siltstone to 260 feet.

Palaeo interval: 232 feet to 1,700 feet. 71 – 518.2m

1,795 feet to 2,770 feet— 547.1 – 844.3m

Probable equivalent to Tambo Formation.

Age: Mesozoic (Cretaceous: Albian).

* Fitzpatrick, B. F., and Wilson, R. B.—Geology of the Innamincka Dome, South Australia. February, 1959.
† Sandford, R. E.—Seismic reflection survey of Innamincka Dome area South Australia and Queensland, Australia. November, 1958 (unpublished).

Light grey to light brown-grey, very carbonaceous soft mudstone; grey very fine-grained, hard calcareous sand to siltstone, traces of brown to buff hard, dense limestone to 2,070 feet, becoming predominantly shale to 2,770 feet, grey, silty to sandy, lignitic, containing occasional fossil shell fragments, with traces of grey, finely crystalline to dense, hard limestone, calcite, and fine-grained hard calcareous silt to sandstone.

Palaeo intervals: Upper Albian, 1,700 feet to 2,280 feet; Middle Albian, 2,280 feet to 2,680 feet; Lower Albian, 2,680 feet to 2,700 feet.

No definite lithological break at base, except that shale becomes calcareous.

2,770 feet to 3,928 feet— 844.3m - 1197.3m

Equivalent to Roma Formation.

Age: Mesozoic (Cretaceous: Aptian).

Grey, hard, calcareous, silty shale, trace pyritic, with traces of grey to brown, medium crystalline to dense limestone, and green to grey, very fine grained, silty sand. Abundant fossil shell fragments 2,770 feet to 3,530 feet, with traces to 3,928 feet.

Palaeo interval: 2,770 feet to 3,920 feet. 844.3 - 1194.8

3,928 feet to 4,665 feet— 1197.3 - 1421.9m

Probable equivalent to upper portion of Blythesdale Group.

Age: Mesozoic (Cretaceous: Neocomian).

Thinly bedded, grey to light grey, very fine-grained, micaceous, silty sand, slightly carbonaceous, tight, well cemented, with light grey silty shale to siltstone from 3,928 feet to 4,390 feet. Predominantly sandstone to 4,665 feet: thick porous beds of bright grey-white so clear, quartz sands, mostly angular, poorly sorted, fine to coarse grains, clean with some silty, interbedded with thin streaks of grey, very sandy shale.

Palaeo interval: 3,920 feet to 4,610 feet. 1194.8 - 1408.2m

4,665 feet to 5,148 feet— 1421.9 - 1569.1m

Probable equivalent to lower portion of Blythesdale Group.

Age: Mesozoic (Upper Jurassic).

Mostly thinly bedded, light grey-white, fine-grained, with some coarse-grained, sandstones to 4,986 feet, mostly hard, fair porosity, becoming shaly and tight in places, micaceous, with grey very sandy shale. Predominantly thicker bedded, medium to coarse grained, mostly clean, porous sand 4,986 to 5,148 feet.

Palaeo interval: 4,610 feet to 5,150 feet. 1408.2 - 1569.7m

5,148 feet to 5,432 feet— 1569.1m - 1655.7m

Probable equivalent to Walloon Coal Measures.

Age: Mesozoic (? Middle Jurassic).

Thinly interbedded, grey to grey-white, very fine to medium grained, micaceous, shaly, tight, carbonaceous sandstone, and grey to dark grey, very carbonaceous, some sandy shale.

Palaeo interval: 5,150 feet to 5,490 feet. 1569.7m - 1673.4m

5,432 feet to 5,938 feet— 1655.7m - 1809.9m

Probable equivalent to Marburg Formation.

Age: Mesozoic (? Lower Jurassic).

Thick bedded to massive, grey white to white, mostly coarse-grained, clean, porous, some poorly sorted sandstone, with very thin streaks of dark grey to grey, very sandy to silty shale.

Palaeo interval: 5,490 feet to 5,920 feet. 1673.4m - 1804.4m

5,938 feet to 6,470 feet— 1809.9 - 1972.0m

Possible equivalent to Bundamba Group.

Age: Mesozoic (? Triassic).

Alternating thin beds of white to grey white, fine to coarse grained, dolomitic sandstone, pale grey to dark grey to brown grey hard, dolomitic shale, with olive green to grey green and brick red shale, some silty, micaceous. The sandstones vary from hard, tight, well cemented to clean and porous.

Palaeo interval: 5,920 feet to 6,541 feet. 1804.4m - 1993.7m

6,470 feet to 6,723 feet—

Possible equivalent to Moolayember Shale.

Age: Mesozoic (? Triassic).

Grey, hard, dolomitic to micaceous shale, brick red, with some pale green-grey shale with scattered thin beds of grey to grey white, fine to medium grained, tight, hard sandstone.

Palaeo interval: 6,541 feet to 6,750 feet.

6,723 feet to 7,050 feet—

Age: Palaeozoic (Permian).

Dark grey to black carbonaceous shale, micaceous in part, grey, fine to coarse grained, tight, carbonaceous, micaceous sandstone, with streaks of fairly clean coal to 6,900 feet, the shales becoming lighter in colour to 7,050 feet, the sand a white, medium to coarse grained, poorly sorted, feldspathic sandstone, pyritic in part, with occasional very large poorly cemented quartz grains.

Palaeo interval: 6,750 feet to 7,010 feet.

7,050 feet to 12,637 feet—

Age: Palaeozoic (? Devonian).

Alternating thin beds of brick red, maroon red, brown and some purple mudstones and shales, red, orange, clear to pale green, mostly fine grained, very tight, well cemented, hard calcareous sandstones. The shale and mudstone are generally calcareous, micaceous, and hard, containing scattered worm tracks, but otherwise essentially void of organic remains. The sandstones, evidencing very little porosity, are generally glauconitic, occasionally micaceous, shaly and may contain potassic feldspar grains. They also are occasionally strongly cross-bedded and often quite gypsiferous. Occasional fracturing occurs below 10,000 feet, with a badly disturbed and distorted section below 11,396 feet. The shatter zone includes vertical shears with apparently considerable displacement. Both fractures and shears may be filled with calcite and or soft red silty mudstone. Average apparent dip is 25°, ranging from 18° to 37°

Palaeo interval: 7,010 feet to 12,637 feet.

STRUCTURE.

Surface geological mapping disclosed a broad, heavily eroded anticline, trending east-north-east, some 50 miles long and 25 miles wide. On the surface an irregular ring of cuesta type escarpments represents gently dipping remnant structural limbs of a heavily eroded dome. The escarpment is more continuous along the strike, though dissected by numerous subsequent drainage streams, and is heavily broken into mesa and butte topography at each end. The structural expression was preserved to a large extent by a silicification of the topographic surface during Tertiary time, forming a hard " duricrust " over the now exposed softer silts and mudstones. The centre of the dome discloses exposed shale and siltstone with calcareous lenses of the Winton Formation (Cretaceous).

The seismic programme confirmed structure at depth, disclosing Mesozoic folding that, for all practical purposes, coincided with structure on the surface. Reflecting horizons within the Mesozoics to a depth of 7,000 feet at the culmination of the structure showed a gently dipping anticline with some 3,000 feet of closure in all directions and covering an area of about 1,290 contourable square miles. Seismic structure within the Palaeozoic below 7,000 feet was found exceedingly difficult to detect, owing to the apparent loss of reflecting markers and perhaps loss of sufficient energy with depth below the " P " (?Top of Palaeozoic) reflector at 7,000 feet.

Nineteen cores were taken to a depth of 7,935 feet, at which point the bore hole was cased with $9\frac{5}{8}$-in. casing. From 7,935 feet to 12,637 feet, sixteen additional cores were cut and a dipmeter survey conducted. Cores 1 to 16 (6,897 feet to 6,904 feet) showed essentially flat-lying sediments with little or no measurable dip, suggesting the bore-hole was probably located near the flat apex of the Mesozoic structure. Lithology of the strata and attitude

of the beds below about 7,050 feet disclosed a definite change in formation, with an apparent pronounced angular unconformity at or about that depth. Conclusions regarding the association of bore-hole and structure can hardly be based on these data alone, especially considering the magnitude and probable complexity of structure at Innamincka. It is more reasonable to offer several avenues of thought and depend upon past or subsequent supporting technical data to assist in an interpretation of structural position of the bore-hole.

A possible line of reasoning would be to assume that the axes of Mesozoic and Palaeozoic structure do not coincide, that the culmination of Palaeozoic structure may be far offset from that of Mesozoic, and that the bore-hole, although correctly located on the Mesozoic apex, was actually drilling well off on the flank of the Palaeozoic structure. If so, and assuming a simple anticlinal fold, the culmination of Palaeozoic structure would lie some miles away with flank dips of 25° to 30°. To date, nothing from a re-interpretation of seismic data has been submitted to substantiate this postulation.

It may be reasonable to assume a considerable hiatus between the depositional period of the " red beds " below 7,050 feet (?Devonian) and the Mesozoic above, ignoring the very thin Permian 6,723 feet to 7,050 feet. If during this hiatus tectonic movement created a Palaeozoic structure, then the top of the Palaeozoics or, rather, the top of the red beds, was probably heavily eroded well into the sedimentary sequence. We know little of Palaeozoic tectonics at Innamincka. They may have been quite intense, with broad major folding accompanied by tight complementary folds, flexures, and shearing. If so, the Innamincka bore-hole may well be located very near the culmination of the major fold; however, it may have cut a minor complementary flexure or a drag-fold associated with shearing or faulting. Cores Nos. 28 to 33, between 11,396 feet to 11,567 feet, showed evidence of vertical displacement in a badly disturbed shear zone.

Technical data obtained from the Innamincka bore-hole relative to structure can be used as an integral part of a re-evaluation of structure through a continued review of seismic results of prior programmes, as well as any subsequent programme. However, we do not feel they are sufficient in themselves to evaluate structure effectively.

Relevance to Occurrence of Petroleum.

The relevance of the geological data to the occurrence of petroleum is discussed only with reference to the local bore-hole area of the Innamincka No. 1 to a maximum depth of 12,637 feet. We do not intend that it should describe areas far removed on the Innamincka anticline, other parts of the Great Artesian Basin, or the rock sequence below total depth.

The strata were analysed to determine their relative value as source material for hydrocarbons. The evaluation was based on the theory that petroleum is derived from sedimentary rocks deposited under conditions ideally favorable for marine life, either plant or animal or both, and that such life is usually minute organisms of a low order or plant spores. The source beds are usually marine shales or marls rich in organic matter and most often dark: the hue is a function of the presence of the organic material. They are usually bituminous or carbonaceous or both. The analysis also considers that trapped petroleum reservoirs are generally close to their source beds.

Innamincka No. 1 encountered mostly non-marine continental deposits to a depth of 7,050 feet, with the exception of the interval 1,795 feet to 3,928 feet. The marine sequence, of gross thickness 2,133 feet, was grey calcareous to carbonaceous mudstones and siltstones

of Lower Cretaceous age (Albian-Aptian), light in colour and apparently relatively lean in organic material. Although fossil shells and shell fragments are found, they are not particularly common. It is doubtful whether any appreciable amount of organic material is buried with the larger fossils. No traces of oil or gas shows were found within the marine section or above it. We do not classify it as being petroleum source material.

The intervals 0 feet to 1,795 feet and 3,928 feet to 6,752 feet are Mesozoic. To a depth of 1,795 feet they are largely carbonaceous mudstones and siltstones of Upper Cretaceous age (Winton). The section 3,928 feet to 6,752 feet was predominantly arkosic sandstone, interbedded with grey, micaceous, some carbonaceous mudstone and siltstone, with red and green silty shale from 6,000 feet to 6,752 feet. Occasional traces of methane gas and oil were found throughout the section. They may well be the result of the decay of brackish-water plant material or humus, inconsequential as an important petroleum source.

The section 6,752 to 7,050 feet was non-marine, Permian, dark grey to light grey, brown, micaceous, carbonaceous siltstone; white, medium to coarse grained, feldspathic sand; dark grey to grey, carbonaceous shale; and streaks of coal between 6,848 feet and 6,890 feet. The discussion concerning the non-marine Mesozoic below 3,928 feet could well apply here with no further comment.

An angular unconformity was encountered at 7,050 feet. The section from that depth to TD 12,637 feet has been dated as (?) Devonian, from rather meagre palaeontological data (*see* report in Appendix 2 by Dr N. H. Ludbrook). The rock sequence from 7,050 feet to 7,300 feet was thinly interbedded, grey to grey brown and white, fine to medium grained, some carbonaceous, some pyritic and glauconitic sandstones, with grey to dark grey, dolomitic, hard shales. The section 7,300 feet to TD 12,637 feet was a monotonous sequence of calcareous, red sandy, and brown with some purple micaceous mudstones, and red, brown, white, green with some pink, fine to medium-grained dense sandstones and siltstones, glauconitic and feldspathic in part. The entire section is thought to be very shallow-water marine epicontinental in origin, with the barest trace of organic remains. No shows of hydrocarbons were encountered throughout the interval. We cannot consider the section 7,050 feet to 12,637 feet as source rock or reservoir material.

Porosity and Permeability.

Several methods were used to determine porosity and permeability of the sediments encountered in the Innamincka No. 1 bore hole. In line with normal accepted oil field practice, experienced geologists were on location throughout the drilling operation to interpret by microscopic examination the extent of porosity as shown by the drill cuttings. Such an analysis, though not mathematical, presented useful information while drilling as to the capabilities of the rock to contain fluid or give up fluids. Terms such as ' tight ', ' dense '. ' loosely consolidated ', ' poorly cemented ', ' friable ', and ' dirty ' are used to describe texture of the rock relative to interstitial porosity and usually quoted as such in lithologic description of the cuttings. Where obvious porosity is noted, it is recorded as such, and only by experience can a rough quantitative estimate be made.

More precise calculations necessarily depend upon physical tools, such as electric or radioactivity logs and cores. During the coring operations, the resident geological supervisor for Delhi made on-the-spot selections of intervals of core recoveries to be analysed, while plug type analyses were run by Core Laboratories, Inc. on location. Results of the core analyses can be noted in Appendix 4.

Electric and radioactivity logs were analysed by Welex engineers and Delhi Australian geological personnel. Because of the nature of the bore-hole sediments and drilling fluid, only average porosities were calculated from the logs, mainly using the Neutron curve, and then compared and rechecked, using the Guard, Contact and electric logs, as well as the drill-cutting lithologic log. Calculations were limited to selected intervals containing sandstone beds where we may assume a degree of permeability.

The calculated Neutron porosities, as listed below, represent total porosity rather than effective porosity: effective porosity may be considerably less. The Neutron porosities were averaged over 10-feet intervals and then averaged into 50-feet intervals, except where long intervals of broken porosity remain fairly constant. The figures thus may not check exactly with core analysis, where many 1-foot intervals of effective porosity were calculated. The calculations may include over the averaged intervals porosity with shale and some tight sand where permeability would probably be so low as to render porosity ineffective. Some intervals of obviously tight shales, mudstones, and siltstones were not calculated for practical reasons.

Depth.	General Description.	Analysis Interval.	Average % Porosity Neutron.	Effective Porosity Core Analysis.	
Feet.		Feet.			
232 to 1,009	Light grey to grey-green soft silty shales, lignitic in part, with thin beds of grey to grey-white fine-grained loosely consolidated sandstone and siltstone	..	No calculations, tight, impervious	..	
1,009 to 1,010	Grey fine-grained hard calcareous, pyritic sandstone	1,009 to 1,010	..	34.7	
1,010 to 3,928	Grey soft very sandy to silty light brown-grey lignitic, micaceous shale and mudstone, and grey hard calcareous, sandy shale, with thin streaks grey to grey-green, very fine-grained, glauconitic sandstone, and grey to brown dense crystal line limestone	..	No calculations, tight, impervious	..	
3,928 to 4,087	Grey fine-grained micaceous, slightly carbonaceous, tight slightly silty sandstone, some pink tight micaceous sandstone	..	..	4,032 to 4,033 4,035 to 4,036 4,038 to 4,039 4,040 to 4,041	12.4 13.4 13.6 13.3
4,087 to 4,390	Mostly light grey to grey silty shale, and grey fine-grained hard, tight thinly bedded sandstone	..	No calculations, tight, impervious	..	
4,390 to 4,957	Light brown-grey to light grey to grey-white, fine to coarse-grained sandstone, some poorly sorted, angular to subangular, clean porous sandstone, with some fine-grained tight hard shaly dirty sandstone interbedded with thin streaks of grey very sandy, slightly micaceous shale	4,390 to 4,450 4,450 to 4,500 4,500 to 4,550 4,550 to 4,600 4,600 to 4,650 4,650 to 4,700 4,700 to 4,750 4,750 to 4,800 4,800 to 4,850 4,850 to 4,900 4,900 to 4,950	15.5 13.1 17.5 17.5 18.0 18.5 21.0 20.7 21.5 24.0 18.0	4,549 to 4,550 4,552 to 4,553 4,533 to 4,557	20.4 22.2 19.8
4,957 to 4,986	Grey very sandy shale ..	..	No calculations		

Depth.	General Description.	Analysis Interval.	Average % Porosity Neutron.	Effective Porosity Core Analysis.	
Feet.		Feet.			
4,986 to 5,148	Grey-white fine to coarse-grained clean porous sandstone with hard shaly tight sandstone. Abundant free clear to milky quartz 5,120 to 5,160 feet	5,000 to 5,050	19.1	5,063 to 5,064	19.4
		5,050 to 5,100	17.5	5,065 to 5,066	21.4
		5,100 to 5,150	16.8	5,068 to 5,069	23.0
5,148 to 5,430	Thinly interbedded, fine to very fine to medium-grained grey to grey white sandstone, some micaceous, and grey to dark grey very carbonaceous shale	5,350 to 5,400	26.5		
		5,400 to 5,430	23.0		
5,430 to 5,940	Grey white, mostly coarse-grained, massively bedded clean porous friable sandstone, some fine to medium-grained hard, tight shaly, with very thin streaks grey to dark grey carbonaceous shale	5,430 to 5,460	14.7	5,570 to 5,571	17.7
		5,460 to 5,500	23.0	5,573 to 5,574	18.9
		5,500 to 5,550	19.6	5,574 to 5,575	21.3
		5,550 to 5,600	18.5	5,576 to 5,577	18.5
		5,600 to 5,700	29.9	5,577 to 5,577.5	19.4
		5,714 to 5,734	19.6		
		5,734 to 5,804	38.7		
		5,809 to 5,909	17.6		
		5,909 to 5,950	25.0		
5,940 to 6,472	White to grey white, fine to coarse grained, porous friable clean sandstone, some shaly, well cemented. Grey to dark grey sandy brick red and olive green shales. Mostly thinly interbedded	5,950 to 6,210	22.0	6,087 to 6,088	7.7
		6,210 to 6,230	10.3		
		6,250 to 6,400	21.5		
		6,400 to 6,410	11.5		
6,472 to 6,808	Mostly pale green-grey sandy, dolomitic brick red and dark grey to black lignitic shale, with occasional thin beds of grey-white, fine to medium grained, tight, some hard sandstone	6,500 to 6,700	23.0		
		6,700 to 6,800	24.5		
6,808 to 7,050	Grey, fine to coarse-grained, tight carbonaceous, micaceous sandstone, with streaks black coal, banded in part. White coarse-grained feldspathic sandstone, some poorly sorted, some pyritic. Streaks of coal, grey to dark grey sandy lignitic, micaceous shale	6,800 to 6,900	20.2	6,823 to 6,824	3.6
		6,900 to 6,950	14.3	6,826 to 6,827	6.2
		6,950 to 6,988	18.5	6,830 to 6,831	5.7
				6,832 to 6,833	7.1
				6,835 to 6,836	6.8
				6,836 to 6,837.4	4.1
				6,897 to 6,898	9.0
				6,898 to 6,899	11.5
				6,900 to 6,001	3.1
7,050 to 12,637	Monotonous alternating thin beds of tight well cemented fine to medium-grained (some coarse), glauconitic, micaceous sand, white to pale green to red to brown. Grey, red, red-brown, green shale	..	No calculations tight, impervious	7,203 to 7,204	4.2

CONTRIBUTION TO GEOLOGICAL CONCEPTS.

Until Innamincka No. 1 was drilled, very little was known about the extent of pre-Mesozoic sedimentation in the wellsite area. Although geophysics had suggested at least 7,000 feet of rocks of Mesozoic age, their classification into stratigraphic units was very

questionable, because no bore-hole in the vicinity had penetrated farther into the section than somewhere in the marine Cretaceous (Patchawarra Bore, total depth 5,458 feet in Albian age shale), and formation could not be defined on geophysical data.

A good deal was known about outcrop areas of the Artesian Basin, and the Mesozoic artesian aquifers, particularly in Eastern Queensland.

Basic concepts of Mesozoic sedimentation in the Innamincka locality have not been materially altered as a result of the Innamincka bore. The rock sequence to 7,050 feet uggests a sedimentary history that basically conforms to Whitehouse's interpretation from his Queensland investigations*. Briefly, strata identified as the artesian aquifier sequence include those formations laid down after the late Permian orogenies that created the Bowen Syncline and what Whitehouse calls the Austrial Geobasin. Sedimentation commenced during late Permian time, when broad, shallow, inland seas or marshlands developed as a result of a gentle subsidence of the older Palaeozoic floor. It continued through several sedimentary stages into and throughout the Mesozoic era, and was predominantly continental with the exception of an interval of Lower Cretaceous time when epicontinental seas invaded the basin from the north, depositing a relatively thick sequence of marine shales and siltstones.

As can be noted from the stratigraphic description of the Innamincka No. 1, the intervals 7,050 feet to 3,928 feet and 1,795 feet to 232 feet include sediments classified as continental or lacustrine from late Permian age to Upper Cretaceous, while the interval 3,928 feet to 1,795 feet represents the Lower Cretaceous marine sequence. Rock age determinations lean heavily upon palaeontological evidence, which is also an important influence in establishing formation boundaries. Formations are generally referred to as " probable or possible equivalents ", because the Innamincka bore-hole cannot establish the lateral extent of a rock unit so as to link it with its marginal basin counterpart. We do not propose, however, any new rock units or formations, but rather suggest that the interval 232 feet to 7,050 feet conforms basically with the recognized Artesian Basin sequence.

The red bed interval, 7,050 feet to TD 12,637 feet, has been suggested as Devonian from very meagre palaeontological evidence, with a distinct possibility of Middle Cambrian age, based on rock lithology. The full extent of the section is not known, as the well was bottomed in red beds after having cut some 5,500 feet of them. It is difficult to diagnose their significance upon such scant data. However, assuming Palaeozoic structure at Innamincka, partial truncation and present known thickness, they are probably quite extensive laterally. They are classed as marine shelf deposits in shallow epicontinental seas. It will be necessary to secure additional data from subsequent test wells in order fully to appreciate their regional significance, and its effect upon oil exploration.

Two important geophysical horizons have been established as correlation markers, with direct relationship to stratigraphy. The " C " seismic reflector was confirmed as the top of the Blythesdale artesian aquifer sand, and the " P " marker, previously called top of Palaeozoic, has been confirmed as top of the Palaeozoic below the unconformity separating the older Palaeozoic from the artesian sequence.

* Whitehouse, F. W., 1954—The geology of the Queensland portion of the Great Australian Artesian Basin. *Appendix G* to Artesian water Supplies in Queensland. *Brisbane, Govt. Printer.*

APPENDIX 1.

PETROGRAPHIC REPORTS.

(*a*) CORE AT 6,551 FEET.*

The rock is a dolomitized sericitic sandstone and is a virtually unaltered sediment. It consists of very angular quartz grains which are of even size and average 40 microns in diameter, enclosed in a very fine grained mass of sericite and kaolin.

The rock is impregnated by some 10 to 15 per cent. of crystalline aggregates of dolomite, which range up to 500 microns in diameter. These dolomite aggregates replace the clay-sericite matrix which is interstitial to the quartz grains. The dolomite is regarded as a secondary metasomatic mineral which has not been affected by any form of metamorphism or stress since its introduction.

The quartz component retains its original form and is not optically strained. Sericite-clay matrix is partly detrital and partly derived from the kaolinization of detrital felspars.

Thus the rock is considered to be of post-Palaeozoic origin, that is, not bedrock in the generally accepted sense.

(*b*) COAL SAMPLE 6,870 FEET TO 6,890 FEET.†

The sample has been analysed with the following result:—

	Proximate Analysis. Per cent.
Moisture	0.82
Volatile	13.89
Fixed carbon	20.79
Ash	64.50
" Fuel Ratio " (fixed carbon/volatiles)	1.5

The latter figure is comparable to the general average of coals from the Lower Triassic basins at Leigh Creek.

(*c*) CHIP FROM CORE AT 6,897 FEET—MICROSLIDE GSQ 170.‡

The core chip has been determined by Miss B. R. Houston as indurated argillaceous quartz sandstone.

The sample fluoresced under ultraviolet light and gave mineral oil " cut " in carbon tetrachloride.

Quartz is the dominant constituent and occurs as subrounded to rounded grains, the average grain size being 0.2 mm. to 0.5 mm. The majority of the grains are unstrained. The mutual boundaries between many of the grains and the presence of a fine quartz mosaic between others suggests that partial recrystallization has taken place. Estimated percentage approximately 65 per cent.

Clastic *feldspar* grains are not abundant. Estimated percentage approximately 3 per cent.

The argillaceous *matrix* is limonite-stained and appears to have been derived from feldspathic material. Fresh sericite is also present, suggesting that slight recrystallization of the matrix has taken place. Estimated percentage approximately 20 per cent.

Fragments of? rhyolite are subrounded, of low sphericity and are similar in size to the quartz grains. Estimated percentage approximately 7 per cent.

Estimated *porosity* approximately 5 per cent. This may only be apparent due to tearing away in thin sectioning.

(*d*) CHIP SAMPLES, 10,104 FEET AND 10,108 FEET.§

10,104 FEET:

A fine-grained sandstone to siltstone, predominantly quartzose. Somewhat iron-stained subangular quartz-grains form the bulk of the rock; orange-red subangular grains of potassic feldspar occur, flakes of sericite, chlorite, and decomposed biotite are fairly common. Fine-grained calcite is present in small amount. Heavy minerals include zircon, tourmaline, opaques. The rock may be classified as a fine-grained, quartzose, micaceous sandstone (grading into siltstone) with a calcite cement.

10,108 FEET:

This rock is very similar to the previous one; however, greater amounts of chlorite, calcite and fresh, colourless feldspars (orthoclase, microcline, albite) are present. Heavy minerals consist of zircon (occasionally euhedral), opaques, garnet. With an increase of micaceous minerals this rock would grade into a fine-grained subgreywacke; it may be classified as a fine-grained, quartzose, micaceous sandstone with a calcite cement.

---

* Report by Department of Mines, South Australia: A. W. Whittle, Chief Mineralogist and Petrologist.
† Repor t by Department of Mines, South Australia.
‡ Report by Miss B. R. Houston, Geological Survey of Queensland.
§ Report by H. W. Fander, Department of Mines, South Australia.

APPENDIX 2.

SUBSURFACE STRATIGRAPHY AND MICROPALAEONTOLOGICAL STUDY.

by

N. H. Ludbrook.*

ABSTRACT.

Innamincka No. 1 Well was drilled to a depth of 12,637 feet and penetrated a sedimentary sequence of Mesozoic and Palaeozoic rocks ranging in age from Cretaceous to (?) Devonian. Marine Cretaceous (Albian) carbonaceous mudstone and siltstone were entered at 1,700 feet and at 3,920 feet the boring passed out of the marine Albian-Aptian sequence into non-marine arkosic sandstone of Neocomian age. Between 4,620 feet and 5,920 feet a non-marine sequence of grey micaceous sandstone and siltstone with coal bands of Jurassic age was intersected, followed by (?) Triassic non-marine red, green and grey sericitic and dolomitic siltstone and white sandstone between 5,920 feet and 6,750 feet. At 6,750 feet the well passed into Upper Permian carbonaceous siltstone and sandstone with coal.

An angular unconformity occurred between 7,010 feet and 7,040 feet, where the well entered a sequence of red beds dipping at 25 degrees. The sediments consist of red and green sandy calcareous siltstone and cross-bedded sandstone, the age of which is not known with certainty but is believed to be Devonian. Boring ceased in these rocks at 12,637 feet.

INTRODUCTION.

This report presents lithological data and stratigraphic data based on identification of mollusca and foraminifera by N. H. Ludbrook and of plant spores by B. E. Balme (University of Western Australia). Both core and cutting samples were examined over the whole sequence; cores were taken at 500-feet intervals and cuttings at 10-feet intervals.

STRATIGRAPHY.

Stratigraphic units in Innamincka No. 1 Well are as follows:—

	Depth (feet).
Cretaceous—	
Winton Formation (Cenomanian)	232 to 1,700
Upper Albian rocks	1,700 to 2,280
Middle Albian rocks	2,280 to 2,680
(?) Lower Albian rocks	2,680 to 2,770
Roma Formation equivalents (Aptian)	2,770 to 3,920
Aptian-Neocomian rocks; Transitional Beds and Blythesdale Group equivalents	3,920 to 4,620
Jurassic—	
Upper Jurassic rocks	4,620 to 5,150
(?) Middle Jurassic rocks	5,150 to 5,490
Lower or Middle Jurassic rocks	5,490 to 5,920
Triassic—	
(?) Triassic rocks	5,920 to 6,541
(?) Triassic rocks	6,541 to 6,750
Permian—	
Upper Permian rocks	6,750 to 7,010
(?) Palaeozoic Red Beds (?) Devonian	7,010 to 12,637

Only the Cretaceous sediments carried foraminifera. The Jurassic, Triassic, and Permian strata were of non-marine origin and completely lacking in marine fossils.

The section penetrated in the well is very similar to that in Topagoruk Test Well No. 1, Alaska (Collins & Bergquist, 1958), except that most of the section in Topagoruk carried foraminifera and other marine fossils.

CRETACEOUS.

The Cretaceous microfaunal sequence is tabulated in Figure 2. Except for a few species described by Howchin (1895) and Crespin (1944, 1953), the foraminifera are undescribed and an open nomenclature has been employed throughout. Specific identifications have been made only where topotype material

* Department of Mines, South Australia.

was available for comparison. The sequence is similar to that in Santos Oodnadatta No. 1 Bore (Ludbrook, 1959), for which 960 feet of continuous core in the Albian-Aptian provided a reliable record of foraminiferal zonation. In Innamincka No. 1 Well only the first appearance of each species in cuttings is regarded as significant in view of the contamination of ditch samples during drilling.

The foraminifera are listed alphabetically in Table 1 with the depth at which they first appeared and their known range elsewhere.

Inoceramus prisms occurred in most samples below 1,850 feet and a few ostracoda were present in nearly all samples below 2,180 feet. Radiolaria occurred below 2,730 feet.

CENOMANIAN—WINTON FORMATION (Thickness, 1,468 feet).

The first samples received came from 232 feet, when the well was in equivalents of the Winton Formation. This consists of a sequence of carbonaceous limestone, calcareous siltstone, and micaceous siltstone and mudstone, with abundant plant remains and coal fragments. With the exception of three pauperate specimens of *Cibicides* at 470 feet no foraminifera were recovered. Most samples below 420 feet contain one or two megaspores of the water fern *Azolla*, which was first identified for the writer by Dr. I. C. Cookson from specimens picked from the Cretaceous of Australian Oil and Gas Company's Loxton Bore. Since then the megaspores have appeared in the Albian-Cenomanian of all bores examined in the Great Artesian Basin.

Azolla is also associated with limonitized iridescent plant fragments which have been observed only in the Albian-Cenomanian of the Basin.

Although it is paralic to some extent the formation is considered to have been deposited mostly in freshwater lagoons.

UPPER ALBIAN (Thickness, 580 feet).

At 1,700 feet the well entered grey carbonaceous and calcareous siltstones and mudstones with arenaceous foraminifera and *Inoceramus* prisms. The calcareous species are relatively rare, and mostly in the lower half of the interval. Mollusca occurring in Core 4 at 2,044 feet to 2,064 feet include *Nucula* cf. *quadrata* Etheridge, *Aucellina hughendenensis* Etheridge, *Inoceramus etheridgei* Eth. fil. and *Inoceramus* sp. *Tatella maranoana* Eth. fil., cf. *Astarte wollumbillaensis* Moore, *Dentalium wollumbillaensis*, and *Natica* (*Lunatia*) *variabilis* Moore.

MIDDLE ALBIAN (Thickness, 400 feet).

Below 2,280 feet there was a sequence of very calcareous siltstones and pyritic limestones with numerous calcareous foraminifera including *Globigerina* sp. 4, related to *G. cretacea* d'Orbigny, which, in uncontaminated material, appears to be restricted to the Middle and ? Lower Albian.

Mollusca occurring in Core 5 at 2,508 feet to 2,520 feet included *Pseudavicula anomala* Moore, *Inoceramus etheridgei* Eth. fil., *Inoceramus* sp., *Aucellina hughendenensis* Etheridge, *Falciferella breadeni* Brunnschweiler, *Falciferella* sp., *Dimitobelus* sp.

The Upper and Middle Albian sequence is equivalent in part at least to the Tambo Formation of Queensland.

(?) LOWER ALBIAN (Thickness, 90 feet).

Calcareous mudstone between 2,680 feet and 2,770 feet contains *Verneuilina howchini* Crespin and *Bigenerina loeblichae* Crespin. The upper limit of these species in Oodnadatta No. 1 Well is the glauconitic zone with abundant brachiopods tentatively placed in the Lower Albian. It is not known with certainty whether the base of the Albian should be placed at 2,680 feet or at 2,770 feet in Innamincka Well, since the glauconitic zone with brachiopods was not present.

APTIAN: ROMA FORMATION EQUIVALENTS (Thickness, 1,150 feet).

This formation is composed of grey carbonaceous pyritic mudstone and glauconitic siltstone with a characteristic foraminiferal succession, in which *Ammobaculoides romaensis* and *Haplophragmoides chapmani* are followed downwards by *Miliammina* sp. 1, *Ammobaculoides coonanaensis*, *Patellina jonesi*, and *Textularia anacooraensis*.

Comparison of the first appearance of foraminiferal species with their known range elsewhere in South Australia is shown in Table 1.

APTIAN-NEOCOMIAN: TRANSITIONAL BED; AND BLYTHESDALE GROUP EQUIVALENTS (Thickness, 700 feet).

Below 3,920 feet the marine Aptian passed conformably into non-marine grey-buff medium arkosic sandstone with micaceous silty patches. The sandstone is tighly packed with only a small mount of cement. Plant remains and coaly matter are abundant. Muscovite is common in the silt patches. The sandstone is lithologically similar to that outcropping on the southern margin of the Basin on the north

eastern flanks of the Flinders Ranges, which are considered to be mostly of Neocomian age, though the uppermost extend into the basal Aptian. B. E. Balme has determined the age of the microflora at 4,043 ft. 6 in. as Neocomian-Aptian.

JURASSIC.

UPPER JURASSIC: BLYTHESDALE GROUP EQUIVALENTS (Thickness, 530 feet).

The non-marine sandstone sequence continues below 4,620 feet and the fine light grey-white loosely consolidated micaceous sandstone with carbonaceous siltstone patches of Core 11 appears to be the equivalent of the lower part of the Blythesdale Group. The microflora at 5,063 feet is considered by B. E. Balme to be of Upper Jurassic age. The upper limit of the Upper Jurassic sandstone has been somewhat arbitrarily placed; the base of the Blythesdale equivalents has been placed at 5,150 feet.

MIDDLE JURASSIC: WALLOON COAL MEASURES EQUIVALENTS (Thickness, 340 feet).

Underlying the sandstone of the Blythesdale Group is a sequence of dark grey micaceous siltstone and carbonaceous siltstone with coal. This formation appears to be equivalent to the Walloon Coal Measures as redefined by Whitehouse (1954, p. 8).

LOWER JURASSIC: MARBURG FORMATION EQUIVALENTS (Thickness, 430 feet).

This formation was entered at 5,490 feet and consists of non-marine light grey to buff white medium to coarse angular somewhat arkosic sandstone with large patches of carbonaceous matter. The microflora is considered by B. E. Balme to be Lower or perhaps Middle Jurassic. The stratigraphical position of the sandstone is comparable with that of the Marburg Formation as described by Whitehouse, 1954, p. 8.

TRIASSIC.

(?) TRIASSIC: (?) BUNDAMBA GROUP EQUIVALENTS (Thickness, 621 feet).

A well marked lithological change occurs at 5,920 feet where the well entered grey sericitic siltstone, dolomitic and arkosic sandstone and very fine-grained grey siliceous shale passing downwards into red and green sericitic siltstone. The age of this formation is not knwn for certain. Its position in the stratigraphic sequence is comparable with that of the Bundamba Group as defined by Whitehouse (1954, p. 7).

(?) TRIASSIC: (?) MOOLAYEMBER EQUIVALENTS (Thickness, 209 feet).

At 6,541 feet the well passed into fine-grained grey dolomitic sericitic siltstone and fine-grained sandstone passing into green and red dolomitized siltstone which turns olive-green on exposure. The age of this formation also is not known with certainty. It may be the stratigraphic equivalent of the Moolayember Shale.

The base of the Mesozoic is somewhat arbitrarily placed at 6,750 feet.

PERMIAN.

UPPER PERMIAN: COAL MEASURES (Thickness, 260 feet).

The youngest Palaeozoic formation in the section is a sequence of dark grey carbonaceous siltstone, silty sandstone, and buff grey arkosic cross-bedded sandstone with abundant muscovite. Sandstones are strongly cross-bedded and plant remains are common. Coal occurred between 6,860 feet and 6,890 feet. At 6,897 feet an introformational conglomerate band with heterogeneous pebbles occurs in buff-grey arkosic sandstone.

The lithology of this formation resembles that of Permian rocks of fluvio-glacial origin in South Australia.

The age of the coal at 6,870 feet to 6,890 feet is determined by B. E. Balme as follows:—

'The microflora is entirely Permian and not older than upper Artinskian. My opinion is that the coal is of Kungurian-Kazanian age, and comes from strata equivalent in age to part of the Newcastle Coal measures in New South Wales and part of the Liveringa Formation in Western Australia.'

PALAEOZOIC (?)DEVONIAN.

RED BED SEQUENCE (Thickness, 5,598 feet).

An angular unconformity occurs in the section between 7,010 and 7,040 feet. Owing to contamination of the cuttings by cavings from overlying formations it is difficult to place the unconformity accurately. At 7,010 feet chips of fine dolomitic silty sandstone with heavy mineral banding are interpreted as belonging to the rocks below the unconformity, but may originate from the (?) Triassic sandstones above. Between 7,010 feet and 7,050 feet the rocks consist of sandstone, pyritic below 7,030 feet.

APPENDIX 2—*continued.*

Below 7,050 feet the well passed through a red bed sequence of siltstone and sandstone. The dominant lithology is of red, chocolate and grey mottled calcareous sandy siltstones with micaceous siltstone, mudstone, and cross-bedded fine sandstone with frequent slump structures. The sandstone and sandy siltstone are characterized by fine to medium fairly well rounded quartz grains set in a fine dense calcareous or dolomitic groundmass with glauconite and mica. Heavy mineral banding is common in the green-grey siltstone near the top of the sequence.

Organic remains are rare and very poorly preserved. Minute calcareous shell fragments were detected in Core 18 at 7,485 to 7,487 feet, including at 7, 487 feet a fragment very closely resembling shells of *Lingula* occurring in beds at the base of the Mootwingee Series. Worm burrows are frequent, and show in most cores as well as occasionally in cuttings. Core at 11,553 feet had a 3-in. band which was extensively burrowed. Burrows are generally parallel to or at a low angle to the bedding. They commonly occur at a lithological change from sandstone to mudstone. B. E. Balme recovered a few dark-coloured pteridophyte pores from core at 7,201 feet.

The red beds are believed to be rapidly deposited geosynclinal sediments. They are lithologically very similar to the Middle Cambrian Lake Frome Group (Daily, 1956, p. 115) but no positive evidence could be obtained to support the correlation. On the slender evidence of the few organic remains recovered, the red bed sequence is tentatively determined as Devonian, thick formations of which occur in Western New South Wales.

The formation dips at approximately 25°. It had not been completely penetrated when the well was abandoned at 12,637 feet.

REFERENCES.

COLLINS, F. R., and BERGQUIST, H. R., 1958.—Test Wells, Topagoruk Area, Alaska. Part 5: Subsurface geology and engineering data. *Prof. Pap. U.S. geol. Surv.*, 305-D, 265–316.

CRESPIN, I., 1944.—Some Lower Cretaceous Foraminifera from bores in the Great Artesian Basin, northern New South Wales. *J. Roy. Soc. N.S.W.*, 78, 17–24.

CRESPIN, I., 1935.—Lower Cretaceous Foraminifera from the Great Artesian Basin, Australia. *Contr. Cush. Fdn*, 4 (1), 26–36.

DAILY, B., 1956.—The Cambrian in South Australia. *In* El Sistemo Cambrico, su Paleogeografia y el Problema de su Base. 20*th int. geol. Cong., Mexico*, 2, 91–147.

HOWCHIN, W., 1895.—Two new species of Cretaceous foraminifera. *Trans. Roy. Soc. S. Aust.*, 19, 198–200.

LUDBROOK, N. H., 1959.—Santos Oodnadatta No. 1 Well, micropalaeontological examination. *S. Aust. Dep. Min., geol Surv. Rep.* 1336. Pal. 3/59 (unpublished).

SPRIGG, R. C., 1958.—Petroleum prospects of western parts of the Great Australian Artesian Basin. *Bull. Amer. Assoc. Petrol. Geol.*, 42 (10), 2465–2491.

WHITEHOUSE, F. W., 1954.—The Geology of the Queensland portion of the Great Australian Artesian Basin. *Appendix G. to* Artesian Water Supplies in Queensland. *Dept. Pub. Works Qld*, 1–20.

TABLE 1.

LOWER CRETACEOUS FORAMINIFERA.

Species.	First appearance.	Known range elsewhere in South Australia.
Ammobaculites australis (Howchin)	2,030 feet to 2,040 feet	Albian–Aptian
Ammobaculites fisheri Crespin	1,980 feet to 1,990 feet	Albian–Aptian
Ammobaculites sp. 3	2,045 ft. 6 in.	L. Albian–Aptian
Ammobaculites minimus Crespin	2,250 feet to 2,260 feet	Aptian
Ammobaculoides romaensis Crespin	2,051 ft. 9 in.	Aptian
Ammobaculoides coonanaensis Crespin	3,160 feet to 3,170 feet	Aptian
Ammomarginulina sp. 1	1,980 feet to 1,990 feet	Albian–Aptian
Anomalina sp. 1	2,530 feet to 2,540 feet	M. Albian–Aptian
Anomalina sp. 2	2,045 ft. 6 in.	M. Albian–Aptian
Anomalina sp. 3	2,840 feet to 2,850 feet	..
Bigenerina loeblichae Crespin	2,740 feet to 2,750 feet	Lower Mid. Albian–Aptian
Bulimina sp. 1	2,600 feet to 2,610 feet	M. Albian–Aptian
Bulimina sp. 2	3,590 feet to 3,600 feet	M. Albian–Aptian
Bulimina sp. 3	3,023 ft. 6 in.	Aptian
Bulimina sp. A	2,380 feet to 2,390 feet	L. Upper Albian–Aptian
Cibicides sp. 1	2,440 feet to 2,450 feet	M. Albian–Aptian
Darbyella sp. 1	3,750 feet to 3,760 feet	Aptian
Dentalina sp. 1	3,020 ft. 3 in.	M. Albian–Aptian
Dentalina sp. 2	2,516 ft. 6 in.	M. Albian–Aptian
Dentalina sp. 3	2,800 feet to 2,810 feet	M. Albian
Dentalinopsis sp. 2	3,220 feet to 3,230 feet	M. Albian–Aptian
Dorothia sp. 2	2,080 feet to 2,090 feet	M. Albian–Aptian
Dorothia sp. 3	2,420 feet to 2,430 feet	M. Albian–Aptian
Epistomina australiensis Crespin	3,160 feet to 3,170 feet	M. Albian–Aptian
Frondicularia sp. 2	2,780 feet to 2,790 feet	..
Gaudryina sp. 1	2,340 feet to 2,350 feet	M.–L. Albian
Gaudryinella sp. 1	3,260 feet to 3,270 feet	L. Albian–Aptian
Gaudryinella sp. 3	2,680 feet to 2,690 feet	Aptian
Gaudryinella sp. 4	3,910 feet to 3,920 feet	..
Globigerina sp. 4	2,490 feet to 2,500 feet	M.–L. Albian
Globulina sp. 1	2,045 ft. 6 in.	M. Albian–Aptian
Guttulina sp. 1	2,513 ft. 8 in.	..
Gyroidina sp. 1	2,280 feet to 2,290 feet	M. Albian–Aptian
Haplophragmoides sp. 1	2,049 ft. 8 in.	U. Albian–Aptian
Haplophragmoides sp. 2	2,120 feet to 2,130 feet	Albian
Haplophragmoides sp. 3	2,670 feet to 2,680 feet	M.–L. Albian
Haplophragmoides chapmani Crespin	2,680 feet to 2,690 feet	L. Albian–Aptian
Haplophragmoides sp. 5	2,750 feet to 2,760 feet	M. Albian–Aptian
Haplophragmoides dickinsoni Crespin	2,049 ft. 8 in.	M. Albian–Aptian
Haplophragmoides sp. 8	2,049 ft. 8 in.	..
Haplophragmoides sp. 9	2,051 ft. 9 in.	..
Hyperammina sp. 1	2,051 ft. 9 in.	U. Albian–Aptian
Involutina sp. 1	2,058 ft. 6 in.	U. Albian–Aptian
Lagena sp. 1	2,770 feet to 2,780 feet	Albian
Lagena sp. 2	2,513 ft. 8 in.	M. Albian
Lagena sp. 5	2,430 feet to 2,440 feet	Aptian
Lenticulina gunderbookaensis Crespin	2,030 feet to 2,040 feet	Albian–Aptian
Lenticulina sp. 3	3,060 feet to 3,070 feet	Albian–Aptian
Lenticulina australiensis Crespin	2,054 ft. 6 in.	Aptian
Lingulina sp. 1	2,560 feet to 2,570 feet	M. Albian–U. Aptian
Lingulina sp. 2	3,020 ft. 3 in.	M. Albian–Aptian
Lingulina sp. 4	2,440 feet to 2,450 feet	..
Marginulina sp. 1	2,045 ft. 6 in.	Albian–Aptian
Marginulina sp. 1A	2,930 feet to 2,940 feet	..
Marginulina sp. 2	2,513 ft. 8 in.	Albian–Aptian
Marginulina sp. 3	2,054 ft. 6 in.	M. Albian
Marginulina sp. 4	2,370 feet to 2,380 feet	M. Albian
Marginulina sp. 5	2,420 feet to 2,430 feet	M. Albian–U. Aptian
Marginulina sp. 5A	2,460 feet to 2,470 feet	M. Albian
Marginulina sp. 6	2,051 ft. 9 in.	M. Albian–Aptian

INNAMINCKA No. 1 WELL.

MICROPALAEONTOLOGICAL LOG.

CRETACEOUS SECTION.

Cuttings (depth in feet).	1,700–1,750	1,750–1,800	1,800–1,850	1,850–1,900	1,900–1,950	1,950–2,000	2,000–2,040	2,040–2,050	2,050–2,060	2,060–2,100	2,100–2,150	2,150–2,200	2,200–2,250	2,250–2,280
	UPPER ALBIAN.													
Core (depth in feet).								4						
Trochammina sp. 8	V	F				V						R		F
Haplophragmoides sp.	V												F	
? *Gaudryinella* sp.		V						R					V	
Textularia sp. 3					F	F	R		R	R	V	R	V	V
Reophax sp. 2					V	V	V		R	V	V	F	V	V
Ammobaculites fisheri						V		V	R		V	V	V	V
Ammomarginulina sp. 1						V		C	F	R		R	V	V
Trochammina sp. 7						V								
Trochammina sp. 2							V	C	F	C	F	F	C	R
Reophax sp. 1							V		V					
Lenticulina gunderbookaensis							V			V		V	V	V
Ammobaculites australis							V				V			V
Haplophragmoides sp. 1								R			V		V	V
Haplophragmoides dickinsoni								F		V		C	C	
Haplophragmoides sp. 8								C						
Ammobaculites sp. 3								R	F		V	V	V	
Spiroplectammina edgelli								V	R	C	R	F	R	R
Verneuilinoides sp. 1								R	R	F	V	R	V	R
Marginulina sp. 1								V		V	V			
Globulina sp. 1								V						
Anomalina sp. 2								R	V					
Hyperammina sp. 1									V			V		
Haplophragmoides sp. 9									C	F	V	R	R	V
Ammobaculoides romaensis									CF					
Spiroplectammina sp. 3									V					
Textularia sp. 1									CF	V	V	V	V	R
Textularia sp. 2									V		V	V	V	
Involutina sp. 1									V			V		
Marginulina sp. 3									V					
Marginulina sp. 6									V			V		
Lenticulina australiensis									V					
Nodosaria sp. 1									V					
Valvulineria sp. 2									C		V	R	R	V
Dorothia sp. 2										V				
Haplophragmoides sp. 2											R			
Vaginulina sp. 2												V		
Robulus sp. 2														V
Valvulineria infracretacea														V
Ammobaculites minimus														
Saracenaria sp. 2														
Gyroidina sp. 1														
Gaudryina sp. 1														
Trochammina sp. 1														
Robulus sp. 4														
Marginulina sp. 4														
Robulus sp. 1														
Bulimina sp. A														
Lingulina sp. 4														
Vaginulina sp. 1														
Nodosaria sp. 5														
Dorothia sp. 3														
Lagena sp. 5														
Marginulina sp. 5														
Pseudoglandulina sp. 2														
Cf. Valvulineria sp. 3														
Trochammina minuta														
Ramulina sp. 1														
Cibicides sp. 1														
Pyrulina sp. 1														
Virgulina sp. 1														
Marginulina sp. 5A														
Marginulina sp. 8														
Globigerina sp. 4														
Saracenaria sp. 3														
Spiroplectammina sp. 2														
Siphotextularia sp. 1														
Quinqueloculina sp. 1														
Lagena sp. 2														
Nodosaria sp. 7														
Marginulina sp. 2														
Pseudoglandulina sp. 1														
Guttulina sp. 1														
Dentalina sp. 2														
Saracenaria sp. 1														
Anomalina sp. 1														
Lingulina sp. 1														
Bulimina sp. 1														
Haplophragmoides sp. 3														
Frondicularia sp. 2														
Haplophragmoides chapmani														
Verneuilina howchini														
Gaudryinella sp. 3														
Marginulina sp. 10														
Bigenerina loeblichae														
Haplophragmoides sp. 5														
Nodosaria sp. 3														
Lagena sp. 1														
Marginulina sp. 7														
Trochammina sp. 5														
Dentalina sp. 3														
Anomalina sp. 3														
Marginulina sp. 1A														
Pelosina lagenoides														
Lingulina sp. 2														
Miliammina sp. 1														
Dentalina sp. 1														
Bulimina sp. 3														
Lenticulina sp. 3														
Ammobaculoides coonanaensis														
Epistomina australiensis														
Dentalinopsis sp. 2														
Gaudryinella sp. 1														
Marginulinopsis subcretaceus														
Nodosaria sp. 8														
Marginulina marreensis														
Bulimina sp. 2														
Patellina jonesi														
Marginulina sp. 11														
Vaginulina sp. 3														
Textularia sp. 4														
Textularia anacooraensis														
Marginulina sp. 13														
Pyrulina sp. 2														
Darbyella sp. 1														
Gaudryinella sp. 4														
Trochammina raggatti														
Textularia sp. 5														

Cuttings (depth in feet).	2,280–2,300	2,300–2,350	2,350–2,400	2,400–2,450	2,450–2,500	2,500–2,510	2,510–2,520	2,520–2,550	2,550–2,600	2,600–2,650	2,650–2,680	2,680–2,770
	MIDDLE ALBIAN.											
Core (depth in feet).						5						
Trochammina sp. 8												
Haplophragmoides sp.												
? *Gaudryinella* sp.												
Textularia sp. 3	V	V						V	V			
Reophax sp. 2	V		V	V	V				V			
Ammobaculites fisheri	V	V	V	V	R				R			V
Ammomarginulina sp. 1	R	R		R	R							V
Trochammina sp. 7												
Trochammina sp. 2	F	R	R	R	R			V	V		R	V
Reophax sp. 1	V				V							
Lenticulina gunderbookaensis			V	V	V						V	V
Ammobaculites australis					V							V
Haplophragmoides sp. 1	V		R	R	R	F		R	V		V	
Haplophragmoides dickinsoni												
Haplophragmoides sp. 8	V		V	V	R							V
Ammobaculites sp. 3					V			V		V		
Spiroplectammina edgelli	R	V	V	R	R	F	V	V		V	V	V
Verneuilinoides sp. 1	R	V	R	R	R		V	R	V	R	V	V
Marginulina sp. 1												
Globulina sp. 1					V	R	R		V		V	
Anomalina sp. 2				V	V	V	V	V	V		F	V
Hyperammina sp. 1												
Haplophragmoides sp. 9	V	V		V	V	V					V	
Ammobaculoides romaensis												
Spiroplectammina sp. 3	V											
Textularia sp. 1		V	R	V	R	R	V	R			V	
Textularia sp. 2					V			V				
Involutina sp. 1		V	V	V	V		V				V	
Marginulina sp. 3				V	V			V				V
Marginulina sp. 6				V								V
Lenticulina australiensis												V
Nodosaria sp. 1	V				V	V					V	V
Valvulineria sp. 2			V		V	V		V	V		V	V
Dorothia sp. 2		V		V	R			V	V	V	V	
Haplophragmoides sp. 2			V						R	V		
Vaginulina sp. 2												
Robulus sp. 2												
Valvulineria infracretacea												
Ammobaculites minimus	V						V					
Saracenaria sp. 2	V											
Gyroidina sp. 1	V	V		R	V	V	C	R	V		V	V
Gaudryina sp. 1		R										
Trochammina sp. 1		F										
Robulus sp. 4			V		F							
Marginulina sp. 4			V									
Robulus sp. 1			V	V	V		V					V
Bulimina sp. A			V	V	V	V	C	V	V			
Lingulina sp. 4				V								
Vaginulina sp. 1				V			V					
Nodosaria sp. 5				V								
Dorothia sp. 3				F	V		V	V	V			V
Lagena sp. 5				V			R					
Marginulina sp. 5				V								
Pseudoglandulina sp. 2				V								
Cf. Valvulineria sp. 3				V	V	V	V				V	V
Trochammina minuta				V	V	V						
Ramulina sp. 1				V	V						V	V
Cibicides sp. 1				R			V	V			V	V
Pyrulina sp. 1					V						V	V
Virgulina sp. 1					V							
Marginulina sp. 5A					V							
Marginulina sp. 8					V							
Globigerina sp. 4					V	R	A	R	C	A	V	C
Saracenaria sp. 3						V	R				V	V
Spiroplectammina sp. 2							V					
Siphotextularia sp. 1							R					
Quinqueloculina sp. 1							V					
Lagena sp. 2							V					V
Nodosaria sp. 7							V					
Marginulina sp. 2							V					
Pseudoglandulina sp. 1							V					
Guttulina sp. 1							V					
Dentalina sp. 2							V					
Saracenaria sp. 1							R				V	V
Anomalina sp. 1								V			V	V
Lingulina sp. 1									V			
Bulimina sp. 1										V		
Haplophragmoides sp. 3											V	
Frondicularia sp. 2											V	
Haplophragmoides chapmani												F
Verneuilina howchini												R
Gaudryinella sp. 3												V
Marginulina sp. 10												V
Bigenerina loeblichae												V
Haplophragmoides sp. 5												V
Nodosaria sp. 3												V
Lagena sp. 1												
Marginulina sp. 7												
Trochammina sp. 5												
Dentalina sp. 3												
Anomalina sp. 3												
Marginulina sp. 1A												
Pelosina lagenoides												
Lingulina sp. 2												
Miliammina sp. 1												
Dentalina sp. 1												
Bulimina sp. 3												
Lenticulina sp. 3												
Ammobaculoides coonanaensis												
Epistomina australiensis												
Dentalinopsis sp. 2												
Gaudryinella sp. 1												
Marginulinopsis subcretaceus												
Nodosaria sp. 8												
Marginulina marreensis												
Bulimina sp. 2												
Patellina jonesi												
Marginulina sp. 11												
Vaginulina sp. 3												
Textularia sp. 4												
Textularia anacooraensis												
Marginulina sp. 13												
Pyrulina sp. 2												
Darbyella sp. 1												
Gaudryinella sp. 4												
Trochammina raggatti												
Textularia sp. 5												

Cuttings (depth in feet).	2,770–2,800	2,800–2,850	2,850–2,900	2,900–2,950	2,950–3,010	3,010–3,020	3,020–3,030	3,030–3,050	3,050–3,100	3,100–3,150	3,150–3,200	3,200–3,250	3,250–3,300	3,300–3,350
	APTIAN.													
Core (depth in feet).						6								
Trochammina sp. 8														
Haplophragmoides sp.														
? *Gaudryinella* sp.														
Textularia sp. 3	V			V	V									R
Reophax sp. 2							R						V	V
Ammobaculites fisheri	V			V		V		V				V	V	V
Ammomarginulina sp. 1														V
Trochammina sp. 7														
Trochammina sp. 2														
Reophax sp. 1														
Lenticulina gunderbookaensis	V													
Ammobaculites australis		V										V		
Haplophragmoides sp. 1	R													
Haplophragmoides dickinsoni						C	A	V	R	R		F	R	F
Haplophragmoides sp. 8														
Ammobaculites sp. 3	R	V	V	V			F						R	R
Spiroplectammina edgelli	V		V	V		V	F	V	V	V		R		F
Verneuilinoides sp. 1	V						F	V		R	R	V	V	F
Marginulina sp. 1														
Globulina sp. 1										V				
Anomalina sp. 2	R	R	V	V								R	V	
Hyperammina sp. 1						R	V							
Haplophragmoides sp. 9											R			
Ammobaculoides romaensis						V						R	V	V
Spiroplectammina sp. 3										V	V			
Textularia sp. 1			V											V
Textularia sp. 2					V								R	V
Involutina sp. 1						R	F	V		V	V	V		V
Marginulina sp. 3														V
Marginulina sp. 6	V					V								
Lenticulina australiensis			V			V				V	V			
Nodosaria sp. 1		V					V					V		
Valvulineria sp. 2							C	V	V	R				R
Dorothia sp. 2														
Haplophragmoides sp. 2			V	V							R		V	
Vaginulina sp. 2														
Robulus sp. 2														
Valvulineria infracretacea													V	V
Ammobaculites minimus														
Saracenaria sp. 2														
Gyroidina sp. 1				V		V	F			V	R			V
Gaudryina sp. 1														
Trochammina sp. 1														
Robulus sp. 4				V			V			V			V	V
Marginulina sp. 4	V									V		V		V
Robulus sp. 1								V						
Bulimina sp. A		C		V								C		
Lingulina sp. 4														
Vaginulina sp. 1						V	V							
Nodosaria sp. 5														
Dorothia sp. 3	V	V	V							V			V	
Lagena sp. 5														
Marginulina sp. 5							R				V			
Pseudoglandulina sp. 2						V								
Cf. Valvulineria sp. 3		V		V										V
Trochammina minuta								V						
Ramulina sp. 1		V	V							V		V		V
Cibicides sp. 1	V	V												
Pyrulina sp. 1		V	V							V		V		
Virgulina sp. 1														
Marginulina sp. 5A														
Marginulina sp. 8														
Globigerina sp. 4	V	F		R						V		V		V
Saracenaria sp. 3							V							
Spiroplectammina sp. 2														
Siphotextularia sp. 1														
Quinqueloculina sp. 1							V							
Lagena sp. 2														
Nodosaria sp. 7														
Marginulina sp. 2				V									V	
Pseudoglandulina sp. 1														
Guttulina sp. 1														
Dentalina sp. 2						V						V		
Saracenaria sp. 1														
Anomalina sp. 1	V	V		V	V		V			V				V
Lingulina sp. 1														
Bulimina sp. 1		V												
Haplophragmoides sp. 3														
Frondicularia sp. 2	V													
Haplophragmoides chapmani				F			V		V	F	R	R	V	V
Verneuilina howchini							V	V	R	F	R	R		V
Gaudryinella sp. 3							F				V	R	R	V
Marginulina sp. 10							V				V			
Bigenerina loeblichae						V			V					V
Haplophragmoides sp. 5		R			V									
Nodosaria sp. 3														
Lagena sp. 1	V						V							
Marginulina sp. 7	V												V	
Trochammina sp. 5		V	V											
Dentalina sp. 3		V										V		
Anomalina sp. 3			V	V		V					F	V		
Marginulina sp. 1A				V										
Pelosina lagenoides						F								
Lingulina sp. 2						V	V							
Miliammina sp. 1							V						V	
Dentalina sp. 1							R			V				
Bulimina sp. 3							F							
Lenticulina sp. 3									V	V				
Ammobaculoides coonanaensis											V			
Epistomina australiensis											R	V		
Dentalinopsis sp. 2												V		
Gaudryinella sp. 1													V	
Marginulinopsis subcretaceus														V
Nodosaria sp. 8														
Marginulina marreensis														
Bulimina sp. 2														
Patellina jonesi														
Marginulina sp. 11														
Vaginulina sp. 3														
Textularia sp. 4														
Textularia anacooraensis														
Marginulina sp. 13														
Pyrulina sp. 2														
Darbyella sp. 1														
Gaudryinella sp. 4														
Trochammina raggatti														
Textularia sp. 5														

Cuttings (depth in feet).	3,350–3,400	3,400–3,450	3,450–3,500	3,500–3,510	3,510–3,550	3,550–3,600	3,600–3,650	3,650–3,700	3,700–3,750	3,750–3,800	3,800–3,850	3,850–3,920	3,920–3,950	3,950–4,000	4,000–4,050
	APTIAN.														
Core (depth in feet).				7											
Trochammina sp. 8															
Haplophragmoides sp.															
? *Gaudryinella* sp.															
Textularia sp. 3														V	
Reophax sp. 2									V						V
Ammobaculites fisheri							V		V			V			
Ammomarginulina sp. 1				V					C	R		V	V	V	
Trochammina sp. 7															
Trochammina sp. 2													V		
Reophax sp. 1	V														
Lenticulina gunderbookaensis							V	V	V	V					V
Ammobaculites australis															
Haplophragmoides sp. 1											V				
Haplophragmoides dickinsoni	V													R	
Haplophragmoides sp. 8															
Ammobaculites sp. 3				V			V		V	V		V		V	
Spiroplectammina edgelli				V		V					V		V		
Verneuilinoides sp. 1				V									V	V	
Marginulina sp. 1															
Globulina sp. 1							V	V	V						
Anomalina sp. 2									V			R			
Hyperammina sp. 1															
Haplophragmoides sp. 9													V		V
Ammobaculoides romaensis												V	V	V	
Spiroplectammina sp. 3												R			
Textularia sp. 1										V	V	V			
Textularia sp. 2	V	V			V			V				V	V		
Involutina sp. 1															
Marginulina sp. 3									V						
Marginulina sp. 6		V					V	V		V					
Lenticulina australiensis			V		V	V	V	V	R	V	V	V	V		
Nodosaria sp. 1											V				
Valvulineria sp. 2							V		V	V	V	V	V	V	
Dorothia sp. 2										V		V		V	
Haplophragmoides sp. 2				V								V			
Vaginulina sp. 2															
Robulus sp. 2															
Valvulineria infracretacea							R			R					
Ammobaculites minimus				V				V				V			
Saracenaria sp. 2															
Gyroidina sp. 1				V								V			
Gaudryina sp. 1							V				V				
Trochammina sp. 1															
Robulus sp. 4	V														
Marginulina sp. 4								V	R						
Robulus sp. 1															
Bulimina sp. A												V			
Lingulina sp. 4															
Vaginulina sp. 1															
Nodosaria sp. 5															
Dorothia sp. 3	V			V		V						V		V	
Lagena sp. 5													V		
Marginulina sp. 5											V				
Pseudoglandulina sp. 2															
Cf. Valvulineria sp. 3							V			R	V	V			
Trochammina minuta						V			F	R	F	R			
Ramulina sp. 1					V	V		V							
Cibicides sp. 1		V		R	V					V		V			
Pyrulina sp. 1					V	V			V		V	V			V
Virgulina sp. 1															
Marginulina sp. 5A															
Marginulina sp. 8												V			
Globigerina sp. 4				C	R	R	V	V	R	R	R	C	F	V	
Saracenaria sp. 3												V			
Spiroplectammina sp. 2												V			V
Siphotextularia sp. 1												R	V		
Quinqueloculina sp. 1							V	V		V					
Lagena sp. 2				V											
Nodosaria sp. 7					V										
Marginulina sp. 2								V							
Pseudoglandulina sp. 1															
Guttulina sp. 1												V			
Dentalina sp. 2											V	V			V
Saracenaria sp. 1															
Anomalina sp. 1				V	V	R	C	R	V		V	V	V	V	
Lingulina sp. 1															
Bulimina sp. 1				V						R	V				
Haplophragmoides sp. 3															
Frondicularia sp. 2															
Haplophragmoides chapmani				R			V	V	R	V	R	F	R	V	V
Verneuilina howchini		V		R			V							V	
Gaudryinella sp. 3				V	V		V	R	V	V		C	R		
Marginulina sp. 10															
Bigenerina loeblichae	V	V	V	V	F	R	R	F	C	F	V	V	R	V	
Haplophragmoides sp. 5	V			V	R	F	R	V	F	R		F		R	
Nodosaria sp. 3															
Lagena sp. 1															
Marginulina sp. 7									R						
Trochammina sp. 5															
Dentalina sp. 3															
Anomalina sp. 3							V					V			
Marginulina sp. 1A				V										V	
Pelosina lagenoides									V	V					
Lingulina sp. 2															
Miliammina sp. 1												F			
Dentalina sp. 1				V			V	V	V	V	V	V		V	
Bulimina sp. 3								V		V	V	R			
Lenticulina sp. 3					V	V			V	V		V		V	
Ammobaculoides coonanaensis								V						R	
Epistomina australiensis															
Dentalinopsis sp. 2															
Gaudryinella sp. 1										V			V		
Marginulinopsis subcretaceus									V	V					
Nodosaria sp. 8			V	V											
Marginulina marreensis					V		V	V	R	V		R			
Bulimina sp. 2						R	R	V	R	V	V				
Patellina jonesi							V	V	R	V					
Marginulina sp. 11							V								
Vaginulina sp. 3								V	R						
Textularia sp. 4									R						
Textularia anacooraensis									C			F	F		
Marginulina sp. 13									V						
Pyrulina sp. 2									V					V	
Darbyella sp. 1										V					
Gaudryinella sp. 4													F		
Trochammina raggatti														F	
Textularia sp. 5															V

←Upper Albian—Middle Albian→

←Equivalents of Tambo Formation in Part→

Aptian

Roma Formation Equivalents

Neocomian Blythesdale Group Equivalents

V	VERY RARE	1– 2	Specimens
R	RARE	3– 5	
F	FREQUENT	6–10	
C	COMMON	11–25	
A	ABUNDANT	> 25	

LOWER CRETACEOUS FORAMINIFFRA—*continued.*

Species.	First appearance.	Known range elsewhere in South Australia.
Marginulina sp. 7	2,790 feet to 2,800 feet	L. Albian–Aptian
Marginulina sp. 8	2,480 feet to 2,490 feet	Aptian
Marginulina marreensis Crespin	3,530 feet to 3,540 feet	Aptian
Marginulina sp. 10	2,730 feet to 2,740 feet	Aptian
Marginulina sp. 11	3,640 feet to 3,650 feet	Aptian
Marginulina sp. 13	3,720 feet to 3,730 feet	Aptian
Marginulinopsis subcretaceus Crespin	3,340 feet to 3,350 feet	Aptian
Miliammina sp. 1	3,020 ft. 3 in.	L. Aptian
Nodosaria sp. 1	2,054 ft. 6 in.	Albian—Aptian
Nodosaria sp. 3	2,750 feet to 2,760 feet	M.–L. Albian
Nodosaria sp. 5	2,410 feet to 2,420 feet	M.–L. Albian
Nodosaria sp. 7	2,513 ft. 8 in.	M. Albian
Nodosaria sp. 8	3,527 feet	M. Albian
Patellina jonesi Howchin	3,610 feet to 3,620 feet	Aptian
Pelosina lagenoides Crespin	3,018 ft. 6 in.	U. Albian–Aptian
Pseudoglandulina sp. 1	2,513 ft. 8 in.	M. Albian–Aptian
Pseudoglandulina sp. 2	2,420 feet to 2,430 feet	M. Albian
Pyrulina sp. 1	2,450 feet to 2,460 feet	Aptian
Pyrulina sp. 2	3,740 feet to 3,750 feet	
Quinqueloculina sp. 1	2,513 ft. 8 in.	Aptian
Ramulina sp. 1	2,440 feet to 2,450 feet	M.–L. Albian
Reophax sp. 1	2,020 feet to 2,030 feet	
Reophax sp. 2	1,930 feet to 1,940 feet	
Robulus sp. 1	2,380 feet to 2,390 feet	M. Albian–Aptian
Robulus sp. 2	2,230 feet to 2,240 feet	M. Albian
Robulus sp. 4	2,360 feet to 2,370 feet	
Saracenaria sp. 1	2,516 ft. 6 in.	M. Albian–Aptian
Saracenaria sp. 2	2,280 feet to 2,290 feet	M.–L. Albian
Saracenaria sp. 3	2,509 ft. 8 in.	M. Albian–Aptian
Siphotextularia sp. 1	2,513 ft. 8 in.	
Spiroplectammina edgelli Crespin	2,049 ft. 8 in.	M. Albian–Aptian
Spiroplectammina sp. 2	2,513 ft. 8 in.	L. Albian–Aptian
Spiroplectammina sp. 3	2,054 ft. 6 in.	M. Albian
Textularia sp. 1	2,054 ft. 6 in.	U. Albian–L. Aptian
Textularia sp. 2	2,058 ft. 6 in.	Albian–Aptian
Textularia sp. 3	1,910 feet to 1,920 feet	L. Albian–Aptian
Textularia sp. 4	3,710 feet to 3,720 feet	Aptian
Textularia sp. 5	4,030 feet to 4,040 feet	Aptian
Textularia anacooraensis Crespin	3,710 feet to 3,720 feet	L. Aptian
Trochammina sp. 1	2,340 feet to 2,350 feet	
Trochammina sp. 2	2,010 feet to 2,020 feet	U. Albian–L. Aptian
Trachammina minuta Crespin	2,440 feet to 2,450 feet	M. Albian–Aptian
Trochammina sp. 5	2,800 feet to 2,810 feet	L. Albian–Aptian
Trochammina raggatti Crespin	3,920 feet to 3,930 feet	Lowermost Aptian
Trochammina sp. 7	1,990 feet to 2,000 feet	Aptian
Trochammina sp. 8	1,700 feet to 1,170 feet	
Vaginulina sp. 1	2,410 feet to 2,420 feet	M. Albian–Aptian
Vaginulina sp. 2	2,170 feet to 2,180 feet	U. Albian–U. Aptian
Vaginulina sp. 3	3,690 feet to 3,700 feet	Albian–Aptian
Valvulineria infracretacea Crespin	2,230 feet to 2,240 feet	M. Albian–Aptian
Valvulineria sp. 2	2,058 ft. 6 in.	Albian–Aptian
cf. *Valvulineria* sp. 3	2,420 feet to 2,430 feet	M. Albian–Aptian
Verneuilina howchini Crespin	2,680 feet to 2,690 feet	L. Albian–Aptian
Verneuilinoides sp. 1	2,049 ft. 8 in.	U. Albian–Aptian
Virgulina sp. 1	2,470 feet to 2,480 feet	

APPENDIX 3.

WATER ANALYSES AND GAS ASSAY.

WATER ANALYSES.*

Analyses.	D.S.T. No. 6.				D.S.T. No. 7.				D.S.T. No. 8.				D.S.T. No. 9.				D.S.T. No. 10.			
	P.p.m.	Me/ litre.	Assumed com-position.	P.p.m.	P.p.m.	Me/ litre.	Assumed com-position.	P.p.m.	P.p.m.	Me/ litre.	Assumed com-position.	P.p.m.	P.p.m.	Me/ litre.	Assumed com-position.	P.p.m.	P.p.m.	Me/ litre.	Assumed com-position.	P.p.m.
Na+ ..	2,837	123.1	$CaCO_3$	57	1,971	85.7	$CaCO_3$	28	2,318	100.7	$CaCO_3$	57	2,353	102.3	$CaCO_3$	38	1,990	86.5	$CaCO_3$	53
K+ ..	..	..	$FeCO_3$	24	..	..	$FeCO_3$	80	..	..	$FeCO_3$	17	..	..	$FeCO_3$	94	..	..	$FeCO_3$	14
Ca++ ..	23	1.15	$MgCO_3$	4	11	0.55	$MgCO_3$	4	23	1.1	$MgCO_3$	4	16	0.8	$MgCO_3$	10	21	1.0	$MgCO_3$	4
Mg++ ..	1	0.08	Na_2CO_3	1,452	1	0.08	Na_2CO_3	1,856	1	0.08	Na_2CO_3	1,988	3	0.2	Na_2CO_3	1,372	1	0.08	Na_2CO_3	1,748
Fe++	11	0.39	Na_2SO_4	221	38	1.4	Na_2SO_4	331	8	0.29	Na_2SO_4	727	45	1.6	Na_2SO_4	818	7	0.25	Na_2SO_4	648
Total cations	..	124.7	..	..	..	87.7	..	..	..	102.2	..	..	..	104.9	..	..	..	87.8	..	..
Cl− ..	3,293	94.1	NaCl	5,429	1,632	46.7	NaCl	2,690	1,882	53.8	NaCl	3,102	2,302	65.8	NaCl	3,794	1,575	45.0	NaCl	2,597
SO_4= ..	150	3.5	..	..	224	5.2	..	..	492	11.4	..	..	553	12.9	..	..	439	10.2	..	..
CO_3= / HCO_3−	872	29.1	..	..	1,112	38.1	..	..	1,172	39.1	..	..	855	28.5	..	..	1,030	34.3	..	..
SiO_2 ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Total anions	..	126.7	..	..	..	90.0	..	..	..	104.3	..	..	..	107.2	..	..	..	89.5	..	..
Total saline matter ..	7,187	..	..	7,187	4,989	..	..	4,989	5,896	..	..	5,895	6,127	..	..	6,126	5,063	..	..	5,064

HARDNESS (AS CALCIUM CARBONATE).

—	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.
Total ..	83	96	77	121	70
Temporary	83	96	77	121	70
Due to Calcium ..	57	28	57	38	53
Due to Magnesium ..	5	5	5	12	5
Due to Iron	21	66	15	81	12

* (1) The analyses were carried out by the Australian Mineral Development Laboratories, Adelaide, South Australia: Thomas R. Frost, Chief Analyst. The results which were given in grams per gallon were converted by the Bureau of Mineral Resources for reading in parts per million and milli-equivalents per litre.

(2) Values for hardness were calculated by the Bureau of Mineral Resources: J. Puchel, Chemist.

APPENDIX 3—*continued.*

SAMPLE OBTAINED FROM D.S.T. No. 10 4,390 FEET TO 4,400 FEET.*

Mark	Gas Sample Per cent.
Hydrogen	3.0
Air	83
Carbon monoxide	4.5
Carbon dioxide	Nil
Methane	9.0
Ethane	None detected

* Report by Australian Mineral Development Laboratories, Adelaide, South Australia: Thomas R. Frost, Chief Analyst.

APPENDIX 4.

CORE ANALYSES.

by

Core Laboratories Inc.

CONVENTIONAL CORES.

CORE No. 1—

Interval: 485 feet to 505 feet, cut 20 feet.

Recovery: 19.7 feet grey silty-sandy shale and shaly siltstone.

Description:

485 feet to 487 feet	grey shale.
487 feet to 489 feet	grey silty shale.
489 feet to 491 feet	grey very shaly siltstone.
491 feet to 493 feet	grey very silty shale.
493 feet to 495 feet	grey silty shale.
495 feet to 497 feet	grey shale.
497 feet to 499 feet	grey shale.
499 feet to 501 feet	grey slightly silty shale.
501 feet to 503 feet	grey slightly silty shale w/lignite.
503 feet to 505 feet	grey-green very shaly siltstone.

CORE No. 2—

Interval: 1,005 feet to 1,025 feet, cut 20 feet.

Recovery: 14.4 feet light grey shaly siltstone and silty shale.

Description:

1,005 feet to 1,007 feet	light grey shaly loosely consol. siltstone.
1,007 feet to 1,009 feet	light grey shaly loosely consol. siltstone.
1,009 feet to 1,011 feet	light grey shaly loosely consol. siltstone lignitic.
1,011 feet to 1,013 feet	light grey shaly loosely consol. siltstone lignitic.
1,013 feet to 1,015 feet	light grey very shaly loosely consol. siltstone lignitic.
1,015 feet to 1,017 feet	light grey very shaly loosely consol. siltstone lignitic.
1,017 feet to 1,019 feet	light grey very shaly loosely consol. siltstone lignitic.
1,019 feet to 1,019.4 feet	light grey silty shale.

ANALYSIS.

Sample Number.	Depth.	Perm. MD's.	Por.	Residual Saturation. Oil. Vol.	Residual Saturation. Oil. Pore.	Residual Saturation. Total Water % Pore.	Prob. Prod.	Remarks.
	Feet.		%					
1	1,009 to 1,010	21	34.7	0.0	0.0	99.2	*	

* No interpretation.

APPENDIX 4—*continued.*

CORE No. 3—

Interval: 1,525 feet to 1,543.5 feet, cut 18.5 feet.

Recovery: 12.5 feet grey brittle shale, slightly waxy lustre, abundant plant fossils, trace black coal or lignite.

Note: Very uniform core from top to bottom—possible lithological break? First shale of the type.

CORE No. 4—

Interval: 2,044 feet to 2,064 feet, cut 20 feet.

Recovery: 15.6 feet grey silty lignitic micaceous shale and grey lignitic siltstone, marine foss shells and casts in shale.

Description:	2,044 feet to 2,045 feet	.. grey, silty, lignitic, micaceous shale.
	2,045 feet to 2,046 feet	.. grey lignitic siltstone.
	2,046 feet to 2,047 feet	.. grey, lignitic shale, marine fossiliferous w/siltstone stringers, grey, lignitic.
	2,047 feet to 2,054 feet	.. grey, silty lignitic, micaceous shale, marine fossil shell casts.
	2,054 feet to 2,060 feet	.. grey shale, marine fossiliferous w/siltstone stringers, grey, lignitic.

Note: Probable formation change.

CORE No. 5—

Interval: 2,508 feet to 2,520 feet, cut 12 feet.

Recovery: 9.7 feet dark grey, brittle, hard shale, very fossiliferous, pyritic, micaceous.

CORE No. 6—

Interval: 3,018 feet to 3,029 feet, cut 11 feet.

Recovery: 10 feet dark grey-black, brittle shale, marine fossiliferous, with conchoidal fracturing along bedding planes.

CORE No. 7—

Interval: 3,526 feet to 3,538 feet, cut 12 feet.

Recovery: 2 feet shale and siltstone.

Description:	3,536 feet to 3,527.8 feet	.. dark grey-black, brittle, micaceous, calcareous shale, fossiliferous, pyritic.
	3,527.8 feet to 3,528 feet	.. soft, grey, shaly siltstone.

Note: Bottom 1.6 feet of core was badly fractured and looked like cuttings.

CORE No. 8—

Interval: 3,937 feet to 3,947 feet, cut 10 feet.

Recovery: 3.2 feet grey carbonaceous and brown, very carbonaceous, micaceous, pyritic, arenaceous shale, with resinous lustre and grey shale.

Description:	3,939.8 feet to 3,940 feet	.. hard, grey, arenaceous shale.
	3,940 feet to 3,942 feet	.. brown, carbonaceous, micaceous, pyritic, arenaceous shale, with resinous lustre.
	3,942 feet to 3,943 feet	.. grey, carbonaceous, arenaceous shale.

CORE No. 9—

Interval: 4,030 feet to 4,048 feet, cut 18 feet.

Recovery: 15 feet grey, very fine-grained, micaceous, slightly carboniferous, very tight, slightly silty sand with some shale.

Description:	4,030 feet to 4,033 feet	.. grey, very fine grain, tight carbonaceous, micaceous sand, slightly silty.
	4,033 feet to 4,034 feet	.. grey-brown, sandy, carbonaceous, micaceous shale.
	4,034 feet to 4,043 feet	.. grey, very fine grain, tight, micaceous, carbonaceous sand.
	4,043 feet to 4,045 feet	.. grey, very fine grain, banded, micaceous sand.

APPENDIX 4—*continued.*

CORE NO. 9—*continued.*

ANALYSIS.

Sample Number.	Depth.	Perm. MD's.	Por.	Residual Saturation.			Prob. Prod.	Remarks.
				Oil.		Total Water % Pore.		
				% Vol.	% Pore.			
	Feet.		%					
2	4,032 to 4,033	0.8	12.4	0.3	2.4	89.5	*	Gas volume, 8.1
3	4,035 to 4,036	0.9	13.4	0.2	1.5	91.0	*	Gas volume, 7.5
4	4,038 to 4,039	2.1	13.6	0.2	1.5	91.2	*	Gas volume, 7.3
5	4,040 to 4,041	0.0	13.3	0.5	3.8	86.4	*	Gas volume, 9.8

* No interpretation.

CORE NO. 10—

Interval: 4,548 feet to 4,559 feet, cut 11 feet.

Recovery: 10 feet clear quartz sand, fine-coarse grained, poorly sorted, angular to subangular, w/some large quartz grains, spotted gold PP fluor. w/traces faint cut. No taste or smell. Core bled water.

ANALYSIS.

Sample Number.	Depth.	Perm. MD's.	Por.	Residual Saturation.			Prob. Prod.	Remarks.
				Oil.		Total Water % Pore.		
				% Vol.	% Pore.			
	Feet.		%					
6	4,549 to 4,550	512	20.4	0.0	0.0	61.3	*	..
7	4,552 to 4,553	722	22.2	0.0	0.0	63.1	*	..
8	4,556 to 4,557	1,440	19.8	0.0	0.0	62.1	*	..

* Preliminary field interpretation—water.

CORE NO. 11—

Interval: 5,059 feet to 5,069 feet, cut 10 feet.

Recovery: 9.5 feet fine to medium grain, white, silty, slightly micaceous sand, with few micaceous, lignitic, brown shale partings.

ANALYSIS.

Sample Number.	Depth.	Perm. MD's.	Por.	Residual Saturation.			Prob. Prod.	Remarks.
				Oil.		Total Water Pore.		
				% Vol.	% Pore.			
	Feet.		%					
9	5,063 to 5,064	588	19.4	0.0	0.0	61.8	*	..
10	5,065 to 5,066	1,350	21.4	0.0	0.0	62.6	*	..
11	5,068 to 5,069	1,802	23.0	0.0	0.0	61.6	*	..

* Preliminary field interpretation—water.

CORE NO. 12—

Interval: 5,569 feet to 5,579 feet, cut 10 feet.

Recovery: 8.5 feet fine-grained, white, silty, lignitic, subangular sand, with dull gold fluorescence and no cut.

2764/61.—3

APPENDIX 4—*continued.*

CORE NO. 9—*continued.*

ANALYSIS.

Sample Number.	Depth.	Perm. MD's.	Por.	Residual Saturation.			Prob. Prod.	Remarks.
				Oil.		Total Water % Pore.		
				% Vol.	% Pore.			
	Feet.		%					
12	5,570 to 5,571	104	17.7	0.0	0.0	66.6	*	..
13	5,573 to 5,574	392	18.9	0.0	0.0	65.0	*	..
14	5,574 to 5,575	1,145	21.3	0.0	0.0	66.5	*	..
15	5,576 to 5,577	743	18.5	0.0	0.0	53.0	*	..
16	5,577 to 5,577.5	365	19.4	0.0	0.0	54.6	*	..

* Preliminary field interpretation—Water.

CORE NO. 13—

Interval: 6,079 feet to 6,089 feet, cut 10 feet.

Recovery: 9.8 feet pale green-brick red-grey-dark grey green, hard, some silty, micaceous shale and grey micaceous silty sand.

Description:

6,079 feet to 6,081 feet	..	pale green, hard, micaceous shale.
6,081 feet to 6,082 feet	..	brick-red, silty shale.
6,082 feet to 6,083 feet	..	pale green, hard, micaceous shale.
6,083 feet to 6,084 feet	..	grey, micaceous, silty shale or mudstone.
6,084 feet to 6,085 feet	..	grey, micaceous, silty and sandy shale.
6,085 feet to 6,086 feet	..	grey, micaceous siltstone.
6,086 feet to 6,087 feet	..	dark grey-green, micaceous, brittle shale.
6,087 feet to 6,088.8 feet	..	grey, micaceous, silty sand.

ANALYSIS.

Sample Number.	Depth.	Perm. MD's.	Por.	Residual Saturation.			Prob. Prod.	Remarks.
				Oil.		Total Water % Pore.		
				% Vol.	% Pore.			
	Feet.		%					
17	6,087 to 6,088	0.0	7.7	0.0	0.0	79.3	*	..

* No permeability.

CORE NO. 14—

Interval: 6,541 feet to 6,552 feet, cut 11 feet.

Recovery: 10.7 feet grey and red, very hard, micaceous shale.

Description:

6,541 feet to 6,542 feet	..	grey, very hard, slightly micaceous shale.
6,542 feet to 6,543 feet	..	grey, very hard, slightly micaceous shale.
6,543 feet to 6,544.5 feet	..	grey, very hard, micaceous shale.
6,544.5 feet to 6,545 feet	..	red, very hard shale.
6,545 feet to 6,546 feet	..	grey, very hard, micaceous shale.
6,546 feet to 6,547 feet	..	grey, very hard, micaceous shale.
6,547 feet to 6,548.5 feet	..	grey, very hard, micaceous shale.
6,548.5 feet to 6,550.5 feet	..	red, very hard shale.
6,550.5 feet to 6,551.7 feet	..	grey, very hard, micaceous shale.

CORE NO. 15—

Interval: 6,821 feet to 6,847 feet, cut 26 feet.

Recovery: 16.4 feet.

CORE NO. 15—*continued.*

Description:

6,821 feet to 6,822 feet	..	grey-black, micaceous, carbonaceous shale, with resinous lustre.
6,822 feet to 6,823 feet	..	grey-black, micaceous, carbonaceous shale, with resinous lustre.
6,823 feet to 6,824 feet	..	grey, fine-medium grained, carbonaceous, micaceous sand, tight, well cemented.
6,824 feet to 6,825 feet	..	grey, fine-medium grained, carbonaceous, micaceous sand, tight, well cemented.
6,825 feet to 6,826 feet	..	grey, fine medium grained, carbonaceous, micaceous sand, tight, well cemented.
6,826 feet to 6,827 feet	..	grey, fine-grained, tight, well cemented sand.
6,827 feet to 6,828 feet	..	grey, fine- very fine-grained, tight, well cemented sand, banded with coal.
6,828 feet to 6,829 feet	..	grey, fine-medium grained sand, with thinly bedded streaks of coal.
6,829 feet to 6,830 feet	..	grey, fine-medium grained sand, with thinly bedded streaks of coal, micaceous.
6,830 feet to 6,831 feet	..	grey, fine-grained, tight, carbonaceous, slightly micaceous sand.
6,831 feet to 6,832 feet	..	grey, fine-medium grained, tight, carbonaceous, slightly micaceous sand, slight bleeding water.
6,832 feet to 6,833 feet	..	grey-brown, coarse-grained sand, poorly sorted, with large quartz grains, very carbonaceous.
6,833 feet to 6,834 feet	..	grey-white, fine-coarse grained, tight, carbonaceous slightly micaceous sand.
6,834 feet to 6,835 feet	..	grey-white, fine-coarse grained, tight, carbonaceous, slightly micaceous sand, slight bleeding water.
6,835 feet to 6,836 feet	..	grey-white, fine-coarse, poorly sorted sand, with large quartz grains, tight, micaceous, carbonaceous sand, slight bleeding water.
6,836 feet to 6,837 feet	..	grey-white, fine-coarse, poorly sorted sand, with large quartz grains, tight, micaceous, carbonaceous sand, slight bleeding water.

ANALYSIS.

Sample Number.	Depth.	Perm. MD's.	Por.	Residual Saturation.			Prob. Prod.	Remarks.
				Oil.		Total Water % Pore.		
				% Vol.	% Pore.			
	Feet.		%					Chloride.
18	6,823 to 6,824	0.0	3.6	0.0	0.0	44.4	*	3,160
19	6,826 to 6,827	0.0	6.2	0.0	0.0	59.6	*	1,675
20	6,830 to 6,831	0.7	5.7	0.2	3.5	36.8	*	2,050
21	6,832 to 6,833	0.7	7.1	0.2	2.8	52.1	*	1,050
22	6,835 to 6,836	0.7	6.8	0.5	7.4	36.8	*	2,290
23	6,836 to 6,837.4	0.0	4.1	0.5	12.2	61.0	*	1,855

* Preliminary field interpretation—No permeability.

CORE NO. 16—

Interval: 6,897 feet to 6,902 feet, cut 5 feet.

Recovery: 4.9 feet, being 8-in. light brown, medium-grained sand, with streaks lignite; 2-in. very coarse conglomerate—pebbles of white fine-grained felspathic sand; 18-in. light brown, medium-grained sand; and 2 ft. 5 in. white, medium-very coarse grained, poorly sorted, felspathic, gritty sand, with kaolinitic matrix.

APPENDIX 4—*continued.*

CORE NO. 16—*continued.*

ANALYSIS.

Sample Number.	Depth.	Perm. MD's.	Por. %	Residual Saturation. Oil. % Vol.	Residual Saturation. Oil. % Pore.	Residual Saturation. Total Water % Pore.	Prob. Prod.	Remarks. Chloride.
	Feet.		—					
24	6,897 to 6,898	1.8	9.0	0.5	5.6	35.5	*	12,100
25	6,898 to 6,899	2.3	11.5	0.2	1.7	47.0	*	7,230
26	6,900 to 6,901	0.0	3.1	0.0	0.0	67.7	*	12,700

* Preliminary field interpretation — No production, too tight.

CORE NO. 17—

Interval: 7,194 feet to 7,207 feet, cut 13 feet.

Recovery: 10.9 feet, dark green, hard, siliceous, very glauconitic, slightly lignitic, silty shale, with pale grey-green, sandy streaks to a grey-black, micaceous, hard, silty shale and very fine-grained, slightly glauconitic, siliceous, very hard sand.

Description:
- 7,194 feet to 7,196 feet .. dark grey-green, hard, siliceous, slightly glauconitic slightly lignitic, silty shale.
- 7,196 feet to 7,198 feet .. above shale has pale grey-green sandy streaks.
- 7,198 feet to 7,199 feet .. very fine-grained, slightly glauconitic, siliceous, very hard sand.
- 7,199 feet to 7,200 feet .. grey-black, very micaceous, hard, silty shale.
- 7,200 feet to 7,202 feet .. above shale shows 30° bedding planes.
- 7,202 feet to 7,205 feet .. grey, very fine-grained, slightly glauconitic, siliceous, silty, salt and pepper, very hard sand.

ANALYSIS.

Sample Number.	Depth.	Perm. MD's.	Por. %	Residual Saturation. Oil. % Vol.	Residual Saturation. Oil. % Pore.	Residual Saturation. Total Water % Pore.	Prob. Prod.	Remarks. Chloride.
	feet.							
27	7,203 to 7,204	0.0	4.2	0.0	0.0	78.6	*	11,720

* No permeability.

CORE NO. 18.—

Interval: 7,477 feet to 7,490 feet, cut 13 feet.

Recovery: 10 feet.

Description:
- 7,477 feet. to 81 ft. 10 in. .. green, very hard, micaceous, dolomitic quartzite, showing a bedding plane of 30°.
- 7,481 ft. 10 in. to 7,487 feet .. red, very hard, calcareous, finely micaceous, silty shale, with thin streaks of grey, dolomitic quartzite.

CORE NO. 19.—

Interval: 7,917 feet to 7,933 feet, cut 16 feet.

Recovery: 7.4 feet.

Description:
- 7,917 feet to 7,922 feet .. red, hard, sandy, calcareous, micaceous (biotite) shale, with numerous small round inclusions (?) crystalline calcareous material. Shale showed unoriented fractures.
- 7,922 feet to 7,924.4 feet .. red shale as above, interbedded with green-grey, fine-medium crystalline sandy, dense dolomite, with abundant large quartz grains glauconite, and biotite.

Note: Dip measurement of probable bedding planes 7,917 feet to 7,919 feet showed maximum of 18°.

APPENDIX 4—*continued.*

CORE NO. 20.—

Interval: 7,995 feet to 8,016 feet, cut 21 feet.

Recovery: 9.4 feet chocolate brown to red, hard, silty, micaceous, slightly calcareous shale. Glauconite from 8,003 feet to 8,004.4 feet, scattered fractures throughout, worm tracks 7,995 feet to 7,996 feet. Dip of bedding planes—23° to 25°.

CORE NO. 21.—

Interval: 8,216 feet to 8,239 feet, cut 23 feet.

Recovery: 21.8 feet reddish-brown, silty, very micaceous, slightly calcareous shale, with scattered irregular streaks of green sandy shale. Average dip 21° to 26°.

CORE NO. 22.—

Interval: 8,392 feet to 8,415 feet, cut 23 feet.

Recovery: 22.8 feet dark reddish-brown, very silty, micaceous, slightly calcareous shale, containing few scattered blue green sandy shale inclusions.

CORE NO. 23.—

Interval: 8,879 feet to 8,899 feet, cut 20 feet.

Recovery: 19.6 feet red-chocolate brown, very micaceous, slightly calcareous shale, with streaks blue-green, calcareous shale 8,883 feet to 8,884 feet, 8,884 feet to 8,884.3 feet, 8,885.6 feet to 8,890 feet, 8,892.9 feet to 8,893 feet, 8,898.2 feet to 8,898.6 feet, few worm tracks filled with calcareous green crystalline-appearing shale throughout. Banded minutely crossbedded zones show apparent dip of 22° at 8,892.8 feet, 22° at 8,889.7 feet, and 20° at 8,883 feet. Bedding faily reliable and regular. No dips whatsoever observed more than 22°. Fine irregular hairline fracture throughout (may be result of coring).

CORE NO. 24.—

Interval: 9,397 feet to 9,414 feet, cut 17 feet.

Recovery: 17 feet.

Description:	9,397 feet to 9,408 feet	.. Shale, dark reddish-brown, brittle, micaceous, slightly silty, scattered fine fracturing with thin beds of blue-green sandy shale.
	9,408 feet to 9,409.1 feet	.. Sand, pale green, hard, micaceous, glauconitic, calcareous, with blue-green sandy shale partings.
	9,409.1 feet to 9,414 feet	.. Shale, dark reddish-brown, silty, very micaceous.
Dips:	9,399 feet to 9,400 feet ..	.. 25°.
	9,403 feet to 9,404 feet ..	.. 25°.
	9,408 feet to 9,409 feet ..	.. 27°.
	9,413 feet to 9,414 feet ..	.. 25°.

CORE NO. 25.—

Interval: 9,887 feet to 9,909 feet, cut 22 feet.

Recovery: 22 feet.

Description:	9,887 feet to 9,888 feet	.. maroon-red, hard, sandy, micaceous shale, with streaks pale green, hard, micaceous, dolomitic shale.
	9,888 feet to 9,889 feet	.. maroon-red, hard, sandy micaceous shale.
	9,889 feet to 9,890 feet	.. thin streaks red, hard, sandy micaceous shale and clear-very light green, fine-grained, calcareous, micaceous, glauconitic sand.
	9,890 feet to 9,891 feet	.. maroon-red, hard, micaceous shale.
	9,891 feet to 9,892 feet	.. maroon-red, hard, micaceous shale, with spotted inclusions, very fine-grained, pale green, very shaly, calcareous sand, worm tracks.
	9,892 feet to 9,893 feet	.. maroon-red, hard, micaceous shale.
	9,893 feet to 9,894 feet	.. red, very sandy, calcareous shale, with spotted inclusions very fine-grained, pale green, very shaly, calcareous sand, worm tracks.
	9,894 feet to 9,895 feet	.. maroon-red, silty, micaceous shale.
	9,895 feet to 9,896 feet	.. maroon-red, silty, micaceous shale.

APPENDIX 4—*continued.*

CORE NO. 25—*continued.*

Description—*continued,*

9,896 feet to 9,897 feet	..	maroon-red, silty, micaceous shale profuse with worm tracks.
9,897 feet to 9,898 feet	..	maroon-red, silty, micaceous shale.
9,898 feet to 9,899 feet	..	maroon-red, silty, micaceous shale profuse with worm tracks.
9,899 feet to 9,900 feet	..	streaked or spotted red-maroon, sandy, micaceous and pale green, slight calcareous, sandy shale, worm tracks.
9,900 feet to 9,901 feet	..	maroon-red, hard, silty-sandy, very slightly calcareous, micaceous shale, profuse with worm tracks.
9,901 feet to 9,902 feet	..	maroon-red, hard, silty-sandy, very slightly calcareous, micaceous shale, profuse with worm tracks.
9,902 feet to 9,903 feet	..	maroon-red, hard, silty-sandy, very slightly calcareous, micaceous shale, with spotted streaks pale green, fine-grained, calcareous, glauconitic sand.
9,903 feet to 9,904 feet	..	pale green-red, hard, very fine-grained, very calcareous, shaly sand, with streaks green, sandy, only slightly calcareous, micaceous shale.
9,904 feet to 9,905 feet	..	maroon-red, micaceous, hard, very slightly calcareous shale, with spotted streaks pale green, sandy, micaceous, slightly calcareous shale, worm tracks.
9,905 feet to 9,906 feet	..	maroon-red, micaceous, hard, very slightly calcareous shale, with spotted streaks pale green, sandy, micaceous, slightly calcareous shale.
9,906 feet to 9,907 feet	..	maroon-red, micaceous, hard, very slightly calcareous shale, worm tracks.
9,907 feet to 9,908 feet	..	maroon-red, micaceous, hard, very slightly calcareous shale, worm tracks.
9,908 feet to 9,909 feet	..	maroon-red, micaceous, hard, very slightly calcareous shale, worm tracks.

Dip (apparent) measures 18° to 22°.

CORE NO. 26.—

Interval: 10,358 feet to 10,381 feet, cut 23 feet.
Recovery: 19.5 feet.

Description:

10,358 feet to 10,359.5 feet	..	no recovery.
10,359.5 feet to 10,361.8 feet	..	sand, very very thin banded, pale green, fine grain, glauconitic, calcareous, with orange specks; shale, red-brown-maroon, hard, sandy, micaceous, bands are slightly crossbedded.
10,361.8 feet to 10,362 feet	..	sand, pale green, hard, as above. Apparent dip—24° to 25°.
10,362 feet to 10,363.1 feet	..	shale, red, very hard, calcareous sandy, with streaks and inclusions of finely fractured above sand.
10,363.1 feet to 10,366.8 feet	..	shale, maroon-red as above.
10,366.8 feet to 10,370.1 feet	..	shale, banded maroon-red shale as above, with sand, clear to pale green to tan-brown, fine grain, glauconitic, micaceous, hard, very tight, calcareous, banding is crossbedded.
10,370.1 feet to 10,372 feet	..	sand, tan-brown, fine-grain, very hard and tight, calcareous, micaceous, finely fractured with orange specks with very thin maroon-red shale partings. Apparent dip—24°.
10,372 feet to 10,373.5 feet	..	sand, pale green, fine-grain, very glauconitic and calcareous, micaceous, hard, tight.
10,373.5 feet to 10,379 feet	..	shale, maroon-red as above, with very finely fractured and broken with few scattered spotted traces pale green sand.
10,379 feet to 10,381 feet	..	no recovery. Worm tracks throughout shale.

CORE NO. 27.—

Interval: 10,881 feet to 10,897 feet, cut 16 feet.
Recovery: 14.8 feet.

CORE NO. 27—*continued.*

Description:	10,881 feet to 10,883.5 feet ..	shale, maroon-red, hard, very silty and micaceous.
	10,883.5 feet to 10,889.5 feet ..	shale, pale maroon-red, hard, sandy and micaceous, calcareous to dolomitic, with sandy shale, blue-green inclusions. Shale has dark bands.
	10,889.5 feet to 10,891.4 feet ..	sand, pale maroon-red, hard, shaly-silty, micaceous and glauconitic, with orange flecks.
	10,891.4 feet to 10,895.8 feet ..	shale, maroon-red, hard, silty and micaceous, with blue-green inclusions.
	10,895.8 feet to 10,897 feet ..	no recovery.
		Worm tracks evident in shale.

Dips:	10,881.2 feet	25°
	10,881.5 feet	25°
	10,883.6 feet	27°
	10,888.3 feet	28°

CORE NO. 28.—

Interval: 11,396 feet to 11,399 feet, cut 3 feet.

Recovery: 3 feet.

Description:	11,396 feet to 11,397 feet ..	shale, deep maroon-red, very hard, very micaceous, with thin streaks sandy, calcareous, micaceous shale, very fractured with polished open faces.
	11,397 feet to 11,399 feet ..	sand, orange-red, fine grain, calcareous, micaceous, very hard, tight, with numerous mostly vertical calcite filled fractures.

Note: One fracture evidenced possible slickensides. Sand was banded, showing minute, very angular crossbedding.

Apparent dip at 11,396.4 feet—22°.

CORE NO. 29.—

Interval: 11,399 feet to 11,423 feet, cut 24.5 feet.

Recovery: 24.5 feet shale, maroon red, hard, with pale green sand inclusions and thin interbedded stringer of orange-red and pale green, fine grain, calcareous, very hard, slightly glauconitic, micaceous, crossbedded sand. Core throughout was heavily fractured, being shattered in part. Fractures filled with calcite to calcitic pale green sand in part, brown-red clayey gouge in part, and open in part, mostly in the red shale. Positive evidence of vertical displacement along vertical (± 85°) shears. Abundant slickensides fracture faces with striations, especially in the red shale. Entire core strongly disturbed. Apparent dip—31° to 35°.

Description:	11,399 feet to 11,400.2 feet ..	sand, pale orange red, fine grain, very hard, tight, slightly glauconitic, slightly micaceous, very calcareous, with shale, banded maroon-red (11,399.8 feet to 11,400.2 feet). Strong complex fracture system, fractures being filled with greenish calcite. Large vertical shear at 65° shows displacement. Good crossbedding in sand. Apparent dip—33°.
	11,400.2 feet to 11,403.6 feet ..	shale, maroon-red, banded with sand, pale red to pale green, fine grain, calcareous. Strong complex fracture system. Major shear evidences vertical displacement of 6½ inches. Fracture plane at 11,402.7 feet shows striations 20° to core. Apparent dip—31°.
	11,403.6 feet to 11,404.2 feet ..	sand, pale green, fine grain, slightly glauconitic, calcareous, with finely banded shale, very hard, maroon-red. Strong complex fracture. Vertical shear at 11,403 feet—65° to core. Vertical shear at 11,402.6 feet—85°. Apparent dip—32°.
	11,404.2 feet to 11,411 feet ..	shale, maroon-red, very hard, brittle, with sand, scattered inclusions of pale green. Strongly shattered, some fractures being filled with calcite, some with calcareous green sand. Many slickensides on fracture surfaces.

CORE NO. 29—*continued.*
Description—*continued.*

11,411 feet to 11,412 feet	..	shale, as above interval, with sheared wedge of pale green sand cutting core in two shear planes at 71° and 67° almost perpendicular to apparent dip of 36°. Shear planes filled with red clayey gouge to ¾ inch.
11,412 feet to 11,417.2 feet	..	shale, as above interval, with few scattered inclusions of pale green sand. Shale is sandy in part. Strong complex fracture pattern. Multiple vertical shears at 11,416 feet to 11,417 feet, with broken shattered band at 11,415.6 feet along bedding plane. Shears filled with red gouge.
11,417.2 feet to 11,419.2 feet	..	sand, pale green, crossbedded, with inclusions and streaks of shale, maroon-red, very fine, shear 11,417.2 feet to 11,419.2 feet being 82° across bedding plane, 22° off strike with apparent dip of 31°. Shows undetermined amount of vertical displacement. Most faces filled with green calcite and sand.
11,419.2 feet to 11,423.5 feet	..	shale, maroon-red as above shale interval, with scattered inclusions of sand, pale green, some being banded. Complex fracture system with most fractures filled with green sand and calcite. Slickensides with striations common along fractures.
		Shear zone ½-in. thick along bedding plane—34°.

CORE NO. 30—

Interval: 11,423 feet to 11,455 feet, cut 32 feet.

Recovery: 31.5 feet shale, red to maroon-red, hard, brittle, in part silty and sandy, with inclusions and occasional streaks green shale and plae green fine grain, very silty sand and red fine grain calcareous sand. Core strongly disturbed with complex cross fracture system, mostly vertical with some horizontal shears, with considerable displacement, with occasional breccia zones of green sand pebbles and red mud gouge.
Apparent dip 11,424 feet to 37°—Poor
Apparent dip 11,445 feet to 35°—Good, but appears sheared out of place.

Description:	11,423 feet to 11,424.5 feet	..	sand, red, fine grain, shaly, crossbedded, with streaks brown-red shale, complex fracture system, badly disturbed and distorted with calcite fill mostly along vertical.
	11,424.5 feet to 11,426.2 feet	..	shale, red, sandy in part, being graded as shaly sand at top. Very shattered showing displacement 11,424.5 feet to 11,424.9 feet, along fracture planes.
	11,426.2 feet to 11,426.3 feet	..	shale, green with angular irregular contact to red shale below. Appears out of place probably being a thin wedge fallen into shear and subsequently squeezed into present position.
	11,426.3 feet to 11,441.1 feet	..	shale, red, with inclusions of pale green shale. Very strongly shattered with numerous shears cutting obliquely to core at various angles. Excellent evidence of displacement indicating considerable movement.
	11,441.1 feet to 11,442.8 feet	..	breccia, zone of shattered red shale, green shale, and pale green sand, with red clay gouge matrix. Several introduced sand pebbles.
	11,442.8 feet to 11,444.1 feet	..	shale, red to 11,443.9 feet; sand, banded pale green with shale, zone badly disturbed and shattered. Complex fracturing filled with green calcite.

CORE No. 30—*continued.*

Description—*continued.*

11,444.1 feet to 11,448.1 feet ..	sand, series of thin red, fine grain, banded streaks to 11,445.1 feet, and shale, reddish-brown to 11,448.1 feet. All apparently of place. Numerous shear planes along dip.Vertical shear 11,446 feet to 11,447.5 feet to 75°. Bands represent blocks slid into shear or fault zone and subsequently squeezed into present position. Strongly fractured throughout. Fractures along possible dip planes of 31° to 38°.
11,448.1 feet to 11,455 feet ..	shale, red with inclusions of pale green shale. Strongly fractured throughout; however, not as disturbed as beds above. Slickensides indicate shears 11,449.3 feet oblique to dip. No bedding.
11,441.1 feet to 11,448.1 feet ..	fault zone, probably with numerous displaced thin bands of sand and shale.

CORE No. 31—

Interval: 11,455 feet to 11,505 feet, cut 50 feet.

Recovery: 14.5 feet sand, pale green, fine grain, crossbedded; shale, maroon-red, hard. Strong fracture system throughout with numerous shears showing displacement. Apparent dip—31° to 34°.

Description:

11,455 feet to 11,458.1 feet ..	shale, maroon-red, hard, with scattered pale green, sandy shale inclusions. Complex fracture system, with calcite and green shale fill. Very sandy from 11,457.5 feet to 11,457.8 feet. Red shale bedding plane contact with sand 11,458.1 feet. Dip 31°.
11,458.1 feet to 11,459 feet ..	sand, red, fine grain, shaly, calcareous. Fractured vertically, filled with calcite and green shale.
11,459 feet to 11,460.2 feet ..	shale, maroon-red, with streaks red sand. Complex very fine fracture system, with probable shear along bedding plane 11,460 feet with stratigraphic displacement.
11,460.2 feet to 11,465.2 feet ..	sand, red to pale green, fine grain, calcareous, finely crossbedded, strongly shattered with calcite and green sand fill. Shearing—11,463.5 feet and 11,464 feet to 11,565.2 feet. Irregular pressure contact at 11,465.2 feet with red shale suggesting red shale is stratigraphically out of place. Apparent dip at 11,460.2 feet 34°, Apparent dip at 11,461.6 feet 31°.
11,465.2 feet to 11,466.6 feet ..	shale, dark red and green, sandy, with red discolouration along fractures. Shear zone 11,466 feet to 11,466.6 feet, 51°. Contact with underlying sand beds of 11,466.6 feet suggests the 1.4 feet of red shale is stratigraphically out of place, being introduced in a shear zone.
11,466.6 feet to 11,469.4 feet ..	sand, red, fine grain, calcareous, strongly crossbedded with inclusions of green, shaly sand and shale. Green colour appears as secondary discolouration along fractures. Strongly disturbed with complex fracture system being shattered from 11,468.1 feet to 11,469.4 feet. Sheared at angle of 54° at 11,468.1 feet, also along apparent bedding plane. Considerable displacement evidence in core.
11,469.4 feet to 11,505 feet ..	no recovery.

CORE No. 32—

Interval: 11,506 feet to 11,544 feet, cut 38 feet.

Recovery: 38 feet shale, red, hard, micaceous, interbedded with sand, pale green to clear to red to brownish-red, fine grain, very calcareous, being crossbedded in part, banded in part. Some very fine fracturing, but not fractured or shattered as previous Cores 28–31. Bedding highly distorted in places appearing as deformed from compressive pressure. Several indications of sedimentary break in geologic column, probably due to tectonic movement with displacement and subsequent compaction: 11,439.4 feet, 11,528.6 feet, 11,521.2 feet, 11,518.6 feet, 11,513.4 feet, 11,508 feet.

CORE NO. 32—*continued.*

Apparent dip: 11,507.5 feet .. .. 30°.
11,518 feet.. .. .. 27°.
11,536 feet.. .. .. 24°.
11,544 feet.. .. .. 24°.

Interpretation is drag zone or at least within fold.

Description: 11,506 feet to 11,508 feet .. sand, red, fine-grain, shaly, micaceous, hard sand, with streaks pale green, very calcareous, hard sand. Few very fine fractures. Contact with red shale below indicates break in geologic column probably due to tectonic movement and subsequent displacement along approximate bedding plane. Apparent dip—11,507.5 feet—30°.

11,508 feet to 11,509.5 feet .. shale, dark red, hard, brittle, with very very thin bands red, fine-grain sand. Finely fractured. Appears quite distorted as if irregularly compressed.

11,509.5 feet to 11,510.8 feet .. sand, banded red shaly, and red shale. Appears very distorted as above, with possible break in column at 11,509.9 feet.

11,510.8 feet to 11,512.7 feet .. shale, red, hard, brittle, slightly micaceous, with trace blue-green shale on slickenside surface 11,511.8 feet along bedding plane. Sandy at base.

11,512.7 feet to 11,513.3 feet .. sand, very crossbedded, red and pale green, fine grain. Contact with red shale below indicates break in geologic column probably by tectonics.

11,513.3 feet to 11,515 feet .. shale or mudstone, mostly red with irregular streaks of inclusions of pale green and red sand.

11,515 feet to 11,518.5 feet .. sand, mostly red, hard, very calcareous, fine grain, being shaly and very crossbedded to banded with pale green sand. Appears very distorted with probable break in geologic column at 11,517.3 feet, being probably a bedding plane shear filled with red mud (½ inch thick). Contact at 11,518.5 feet indicates break in geologic column probably because of tectonic movement. Apparent dip 11,518 feet—27°.

11,518.5 feet to 11,521.2 feet .. shale, red banded with sand, red becoming pale green 11,520.9 feet to 11,521.2 feet. Appears distorted with break in geologic column at 11,521.2 feet on contact with massive red mudstone bed.

11,521.2 feet to 11,526.2 feet .. mudstone, massive red, very brittle. Finely fractured, but probably subsequent to coring.

11,526.2 feet to 11,528.8 feet .. sand, red, fine grain, banded with mudstone, red, with scattered inclusions pale green sand. Appears very distorted. Break in geologic column along approximate bedding plane 11,528 feet with red shale below. Probable displacement, shear 1½ inches being filled with dark red mud.

11,528.8 feet to 11,533.4 feet .. mudstone, massive red with few scattered inclusions pale green, sandy, calcareous shale. Contact with sand below indicates slight break in sedimentary sequence although fairly well squeezed together.

11,533.4 feet to 11,534.5 feet .. sand, red, crossbedded, fine grain, calcareous, with few very thin streaks reddish-brown shale 11,534 feet to 11,534.5 feet appearing quite distorted.

11,534.5 feet to 11,537.1 feet .. sand, banded very crossbedded, red, very hard, fine grain, calcareous and pale green to clear, very hard, very calcareous, slightly glauconitic sand. Slickenside shear along bedding plane contact with red mudstone at 11,537.1 feet. Fractured across bedding plane. Apparent dip 11,535.1 feet—24°.

CORE NO. 32—*continued.*

Description—*continued.*

11,537.1 feet to 11,538 feet	..	mudstone, red, hard, slightly micaceous, brittle. Probably a shear fill; however, broken too badly on subsequent contact to tell.
11,538 feet to 11,539.4 feet	..	sand, very thinly banded and crossbedded, pale green and red, fine grain, very hard, calcareous. Contact with red mudstone at 11,539.4 indicates definite break in geologic column probably due to tectonic movement and displacement along bedding plane. Diagonal open fractures across bedding.
11,539.4 feet to 11,541 feet	..	mudstone, red.
11,541 feet to 11,542.5 feet	..	sand, red, fine grain, interbedded or banded with shale, dark red, appearing very distorted.
11,542.5 feet to 11,544 feet	..	sand, very crossbedded red and pale green, fine grain, very calcareous, thinly banded with red shale appearing very distorted. Apparent dip 11,543.8 feet—24°.

CORE NO. 33.—

Interval: 11,544 feet to 11,567 feet, cut 23 feet.

Recovery: 23 feet.

Description:

11,544 feet to 11,544.9 feet	..	pale green, fine-grained, glauconitic, calcareous orange flecked, finely crossbedded sand. Apparent dip 11,544.5 feet—29°.
11,544.9 feet to 11,547.2 feet	..	maroon-red, brittle, micaceous claystone, with streaks of pale green, calcareous, silty, very fine-grained sand. Apparent dip 11,545.8 feet—26°.
11,547.2 feet to 11,550 feet	..	pale green to red-brown, hard, calcareous, glauconitic, shaly, crossbedded sand, with numerous streaks of maroon-red shale.
11,550 feet to 11,552 feet	..	red-brown, brittle, very micaceous, silty shale.
11,552 feet to 11,552.2 feet	..	blue-green, brittle, silty shale.
11,552.2 feet to 11,553.3 feet	..	red-brown to blue-green, shaly, crossbedded sand and sandy shale.
11,553.3 feet to 11,557.3 feet	..	red-brown, brittle, very micaceous shale, with thin streaks of red-brown, crossbedded sand. Apparent dip 11,553.3 feet—26°.
11,557.3 feet to 11,559.2 feet	..	red-brown, brittle, very micaceous claystone.
11,559.2 feet to 11,559.7 feet	..	red-brown, hard, very fine-grained, calcareous, micaceous, crossbedded sand.
11,559.7 feet to 11,567 feet	..	red-brown, brittle, sandy, very micaceous shale, with scattered blue-green inclusions of sandy shale, with thin streaks red-brown, fine-grained, very silty, calcareous, finely crossbedded sand. Apparent dip 11,564.5 feet—22°.

CORE NO. 34.—

Interval: 12,067 feet to 12,088 feet, cut 21 feet.

Recovery: 14.5 feet.

Description:

12,067 feet to 12,070.3 feet	..	shale, red-brown, brittle, sandy, micaceous, with thin streaks of brown crossbedded sand. Apparent dip 12,067.4 feet—26°.
12,070.3 feet to 12,072.4 feet	..	sand, red-brown, hard, micaceous, very shaly, calcareous, and shale red-brown, very sandy. Apparent dip 12,071.8 feet—26°.
12,072.4 feet to 12,074.2 feet	..	sand, tan to pale green, very hard, calcareous, micaceous, glauconitic, orange specked, crossbedded. Crossbedding 12,072.3 feet—38°. Apparent dip: 12,073 feet—28°; 12,074 feet—26°.
12,074.2 feet to 12,077.3 feet	..	claystone, maroon-red, brittle, silty, finely fractured with thin streaks of pale green, fine-grain, calcareous sand.

CORE No. 34—*continued.*
Description—*continued.*

12,077.3 feet to 12,081.5 feet	..	sand, red-brown to pale green, fine-grain, hard, calcareous, micaceous, glauconitic, orange specked crossbedded. Apparent dip 12,080.1 feet—26°.
12,081.5 feet to 12,088 feet	..	no recovery. Erosional unconformity (?) 12,070.5 feet, 12,074 feet.

CORE No. 35.—

Interval: 12,576 feet to 12,586 feet, cut 10 feet.

Recovery: 10.0 feet mudstone, red with very thin traces of sand and scattered inclusions of green shale. Apparent dip—24°.

APPENDIX 5.

WELL VELOCITY SURVEY
by
S.A. DEPARTMENT OF MINES.

GENERAL.

A velocity survey was made in the Delhi-Frome-Santos Innamincka No. 1 Well on 9th July 1959 by the Geophysical Section of the South Australian Department of Mines. All original data have been forwarded to Mr. J. C. Ryan, Exploration Supervisor, Delhi Australian Petroleum Ltd.

At the time of the survey, the well had been drilled to a depth of approximately 7,930 feet and was cased to a depth of 4,018 feet.

A Department of Mines shothole drill arrived at the well on 27th June and began drilling on 28th June. Other equipment for the survey was borrowed as follows:—

A portable well survey kit from W.A. Petroleum Ltd, Perth.

A cable lead and three component well geophone from G.S.I., Perth.

A winch truck with 12,000 feet of Schblumberger type cable from O. D. & E. Ltd, Sydney.

Messrs. N. Edwards of Schblumberger and J. Hennessy of O. D. & E. assisted in the survey and gratitude is expressed to them and the above-mentioned companies for their assistance.

PROCEDURE.

Three groups of shotholes were laid out on a northeast-southwest line as shown in the layout plan, Plate 2. Twelve geophone stations were shot, three being checked from double the shothole distance from the well, and four from shotholes on the opposite side of the well. Depths shot ranged from 2,100 feet to 7,850 feet below ground level.

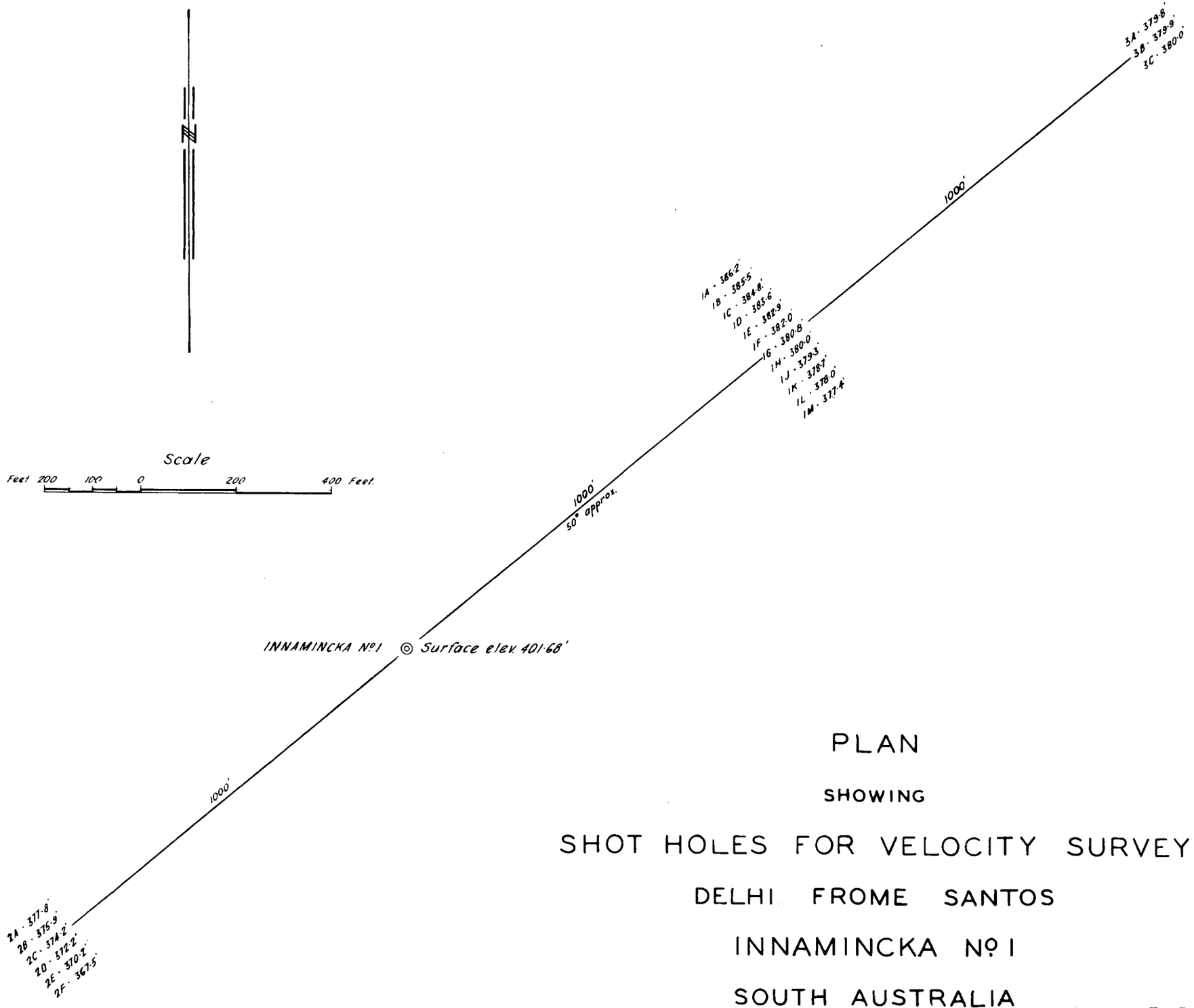
Shotholes were not cased and collapsed after firing once or twice. An uphole survey for sub-weathering velocity was not then possible and a figure of 6,500 feet/second, obtained during a recent reflection correlation survey in the Innamincka area, has been used. A working datum was adopted at the level of the deepest charges.

DATA AND RESULTS.

This report includes the following:—

(1) A plan showing the geographical location of the well (Plate 1).
(2) A plan showing the survey layout (Plate 2).
(3) Cross-section along base line of survey (Plate 3).
(4) Velocity computation sheet (Plate 4).
(5) Graphs showing the final results of the survey (Plate 5).
(6) Copies of original records.*

* The original records may be consulted at the Bureau of Mineral Resources, Canberra.



PLAN

SHOWING

SHOT HOLES FOR VELOCITY SURVEY

DELHI FROME SANTOS

INNAMINCKA No 1

SOUTH AUSTRALIA

FIGURE 3

59·262 MAL S. A. DEPT. OF MINES

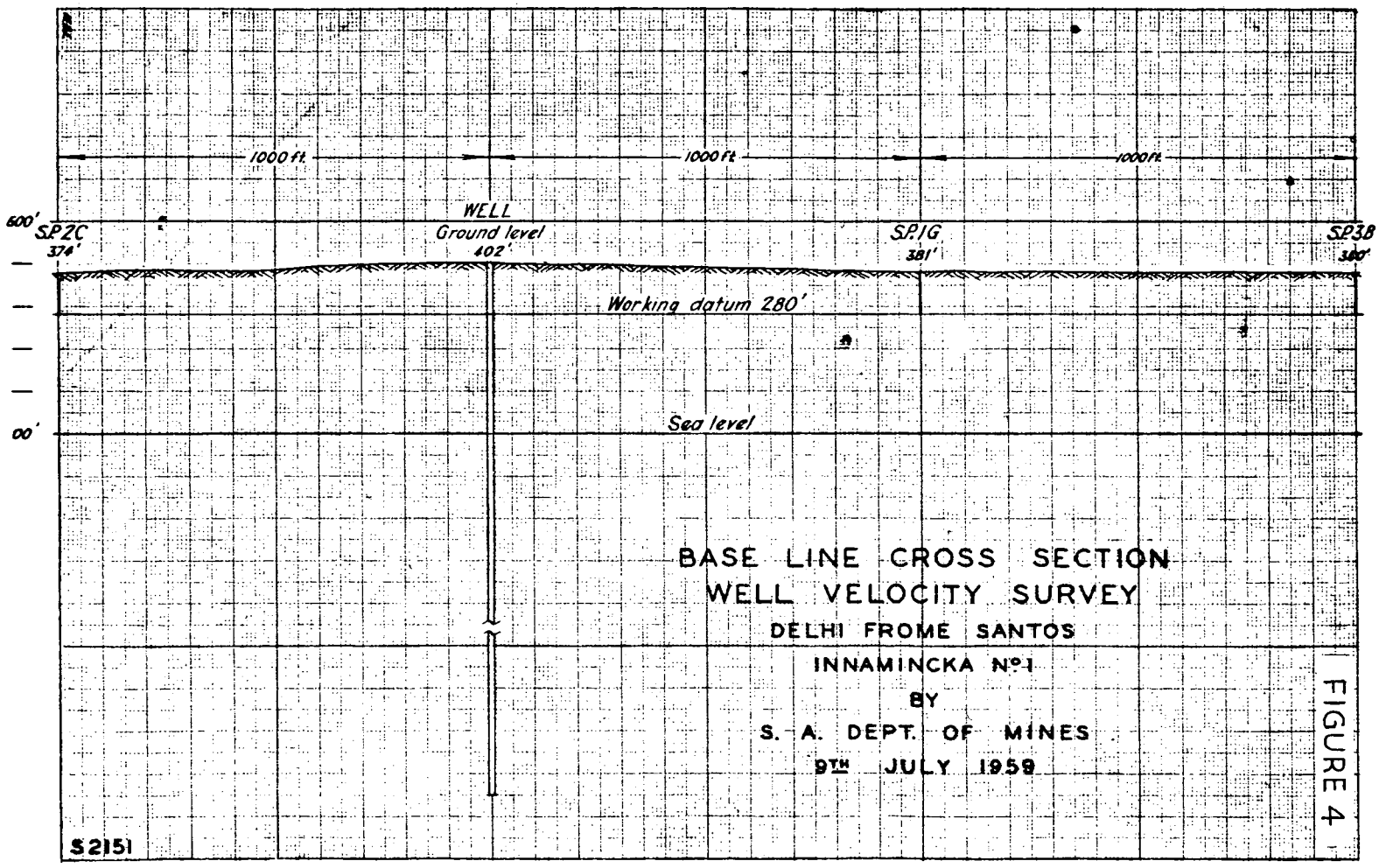

1000 ft
1000 ft
1000 ft
WELL
Ground level
402'
S.P.2C
374'
S.P.1G
381'
S.P.3B
380'
600'
Working datum 280'
Sea level
00'
BASE LINE CROSS SECTION
WELL VELOCITY SURVEY
DELHI FROME SANTOS
INNAMINCKA No.1
BY
S. A. DEPT. OF MINES
9TH JULY 1959
S 2151

FIGURE 4

S2152 M.B.L.

Shothole Information—Elevation, Distance & Direction from Well			
1A – 1M	1000 ft.	NE	
3A – 3C	2000 ft.	NE	
2A – 2D	1000 ft.	SW	

Department of Mines Well

DELHI - FROME - SANTOS

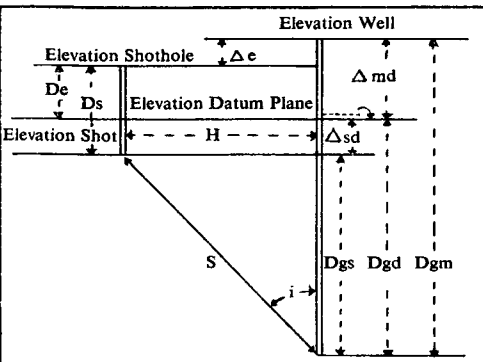
INNAMINCKA No. 1

Elevation	Total Depth
Ground	
402	

LOCATION			
Coordinates	Section, Township, Range	County	Area or Field
	South Australia		Wildcat

Record Number	Shothole Number	Dgm	Ds	tus	tr	T			Dgs	H	cotan i	cos i	Tgs	△sd	△sd/V	Tgd	Tgd Average	Dgd	△Dgd	△Tgd	Vi Interval Velocity	Va Average Velocity
						Reading	Polarity	Grade														
1	1F	2100	102	.036	.208	.301	U	P	1978	1000	1.978	.8925	.2686	+2	−.0005	.2683		1978				7372
2	3B	,,	100	.038	.366	.380		P	1978	2000	0.989	.7032	.2672	0	0	.2672		,,	700	.0846	8274	
4	1D	2800	102	.038	.200	.377	U	G	2680	1000	2.680	.9369	.3532	+2	−.0003	.3529		2678				7589
3	3A	,,	102	.039	.353	.441	U	G	2676	2000	1.338	.8011	.3533	−2	+.0003	.3536		,,	1120	.1262	8875	
5	1B	3920	102	.043	.196	.496	U	G	3802	1000	3.802	.9671	.4797	+4	−.0006	.4791		3798				7927
6	3C	,,	102	.039	.355	.541	U	G	3796	2000	1.898	.8847	.4786	−2	+.0003	.4789		,,	140	.0130	10769	
7	1C	4060	102	.040	.199	.508	U	G	3941	1000	3.941	.9693	.4924	+2	−.0003	.4921		3938				8002
20	2B	,,	102	.037	.216	.503	U	P	3932	1000	3.932	.9691	.4875	−6	+.0009	.4884		,,	440	.0384	11458	
8	1G	4500	102	.040	.200	.544		F	4377	1000	4.377	.9748	.5303	−1	+.0002	.5305		4378	500	.0370	13514	8253
9	1H	5000	102	.039	.203	.579	U	P	4876	1000	4.876	.9796	.5672	−2	+.0003	.5675		4878	500	.0367	13624	8596
10	1J	5500	102	.039	.202	.614	U	P	5375	1000	5.375	.9832	.6037	−3	+.0005	.6042		5378				8901
19	2C	,,	102	.037	.217	.617	U	P	5372	1000	5.372	.9831	.6066	−8	+.0012	.6078		,,	500	.0430	11628	
11	1K	6000	102	.038	.205	.656		P	5875	1000	5.875	.9858	.6467	−3	+.0005	.6472		5878	700	.0536	13060	9082
12	1L	6700	103	.036	.205	.708	U	P	6573	1000	6.573	.9887	.7000	−5	+.0008	.7008		6578	350	.0235	14894	9386
13	1M	7050	102	.035	.205	.731		F	6923	1000	6.923	.9898	.7235	−5	+.0008	.7243		6928				9565
18	2D	,,	102	.034	.215	.726	U	P	6918	1000	6.918	.9898	.7186	−10	+.0015	.7201		,,	150	.0088	17045	
14	1A	7200	102	.042	.197	.741		P	7082	1000	7.082	.9902	.7337	+4	−.0006	.7331		7078				9655
16	1F	,,	60	.031	.205	.739	U	P	7120	1000	7.120	.9903	.7318	+42	−.0065	.7253		,,	650	.0460	14130	
15	1F	7850	80	.028	.207	.789	U	F	7750	1000	7.750	.9918	.7825	+22	−.0034	.7791		7728				9919
17	2A	,,	102	.034	.218	.787	D	F	7724	1000	7.724	.9917	.7805	−4	+.0006	.7811		,,				

All elevations relative to sea level



Dgm = Geophone depth measured from well elevation
Dgs = ,, ,, shot
Dgd = ,, ,, datum
Ds = Depth of shot
De = Shothole elevation to datum plane
H = Horizontal distance from well to shotpoint
S = Straight line travel path from shot to well geophone
tus = Uphole time at shotpoint
T = Observed time from shotpoint to well geophone
tr = ,, ,, to reference geophone
△e = Difference in elevation between well & shotpoint
△sd = ,, ,, shot & datum plane
△sd = Ds − De
Dgs = Dgm − Ds ± △e : $\tan i = \frac{H}{Dgs}$

Tgs = cos i T = vert. travel time from shot elev. to geophone
Tgd = Tgs ± $\frac{\triangle sd}{V}$,, ,, datum plane ,, ,,

Dgd = Dgm − △md
Vi = Internal velocity = $\frac{\triangle Dgd}{\triangle Tgd}$
Va = Average ,, = $\frac{Dgd}{Tgd}$

Surveyed by S.A. Dept. of Mines

Date 9th July 1959

Weathering Data V = 6500 ft/sec
(from Innamincka Reflection Survey)

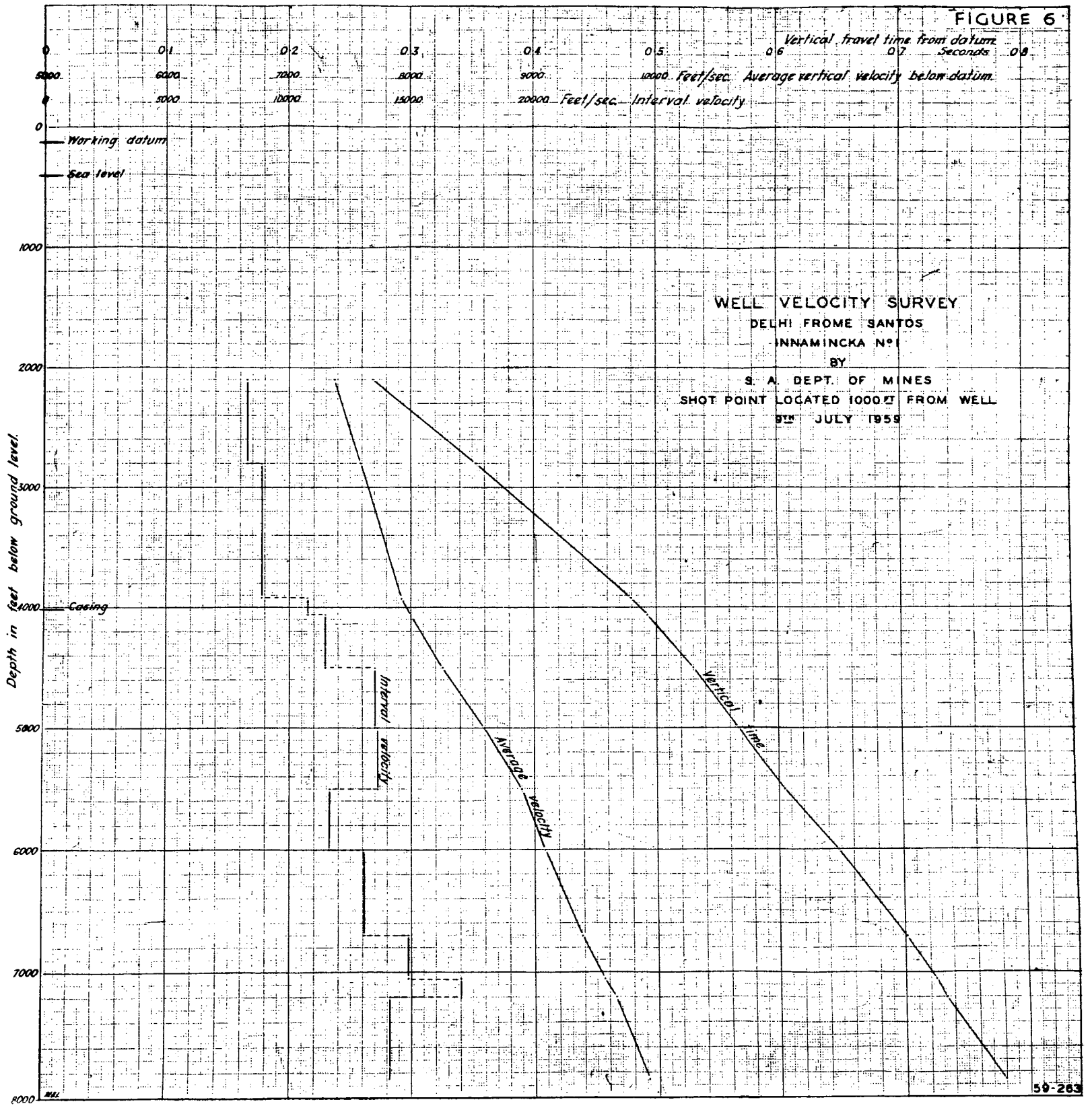
Working datum 280′

Casing Record 4018′

Well Velocity Calculation Form

PLATE 5

FIGURE 6


Vertical travel time from datum
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
Seconds
0.8
5000
6000
7000
8000
9000
10000 Feet/sec. Average vertical velocity below datum
5000
10000
15000
20000 Feet/sec. Interval velocity
0
Working datum
Sea level
1000
2000
3000
4000
Casing
5000
6000
7000
8000
Depth in feet below ground level.
Interval velocity
Average velocity
Vertical time
WELL VELOCITY SURVEY
DELHI FROME SANTOS
INNAMINCKA No 1
BY
S. A. DEPT. OF MINES
SHOT POINT LOCATED 1000 FT FROM WELL
9TH JULY 1959
59-263

The trace arrangement of the records is in the following order, from top to bottom:—

(1) Horizontal geophone No. 1, high amplification.
(2) Horizontal geophone No. 1, medium amplification.
(3) Horizontal geophone No. 1, low amplification.
(4) Horizontal geophone No. 2, high amplification.
(5) Horizontal geophone No. 2, medium amplification.
(6) Horizontal geophone No. 2, low amplification.
(7) Vertical geophone high amplification.
(8) Vertical geophone, medium amplification.
(9) Vertical geophone, low amplification.
(10) Uphole geophone.
(11) Reference geophone at top of well.
(12) Shot instant.
(13) Tuning fork.

DISCUSSION OF RESULTS.

It was necessary to conduct the survey as quickly as possible to minimize idle rig time, requiring the drilling and charging of shot holes prior to the actual day of the survey. The probability that the holes would not stand up to repeated firing meant that an ample number of holes had to be drilled and a variety of charge sizes loaded considering the possibility of cable or casing breaks. No trouble was met with from these breaks but it became extremely difficult to estimate correct amplifier gain settings with the result that many records are over noisy. In general the quality of the seismic breaks is poor to fair and the reliability of the velocity determined for the short interval 7,050 feet to 7,200 feet is questionable. Generally breaks from the vertical geophone have been used and their polarity and grade noted on the computation sheet. In some records where the break from the vertical geophone is poor and a more definite break appears on one of the other traces the latter has been used.

APPENDIX 6.

FORMATION TESTING.

OPEN HOLE DRILL STEM TESTS.

D.S.T. No. 1—4,780 feet to 4,805 feet.

Tool open 30 inches. Immediate weak air blow remaining throughout test. Recovered 20 feet sl O & G C M. I & F mud pressure 2,500 lb. I & FFP 0 to 80 lb. No SIP recorded.

D.S.T. No. 2—6,886 feet to 6,897 feet.

Tool open 20 inches. SI 10 inches. Recovered 100 feet V S1 O C rat hole mud. I & FFP 0 to 80 lb. 10 minutes SIP 600 lb.

D.S.T. No. 3—11,687 feet to 11,727 feet.

Used 3,000 foot water cushion. Packer failed.

D.S.T. No. 4—11,658 feet to 11,727 feet.

Used 3,600 foot water cushion. Packer failed.

DRILL STEM TESTS THROUGH CASING PERFORATIONS.

D.S.T. No. 5 through perforations 6,876 feet to 6,895 feet, 6,855 feet to 6,865 feet, 6,830 feet to 6,850 feet, and 6,810 feet to 6,820 feet.

Went in hole with Howco Hydra-Spring test tool and tested above perforations. Packer was set at 6,796 feet. Three-eighth-in. bottom by ½-in. top chokes. No water cushion. Tool was opened at 8.00 p.m. There was no blow for 49 minutes. A weak blow started at 50 minutes and continued for 7

hours 40 minutes. The surface pressure never reached 1 p.s.i. The tool was closed in for 2 hours and was open for a total of 9 hours 20 minutes. It was obvious that this was not a normal test and recovery was 5,220 feet of drilling mud. The charts revealed that the tool had been open going in the hole, resulting in a misrun. The bottom 630 feet of the mud showed some evidence of being gas cut. Chlorides of the mud filtrate were 1,800 p.p.m. Since the test gave no usable information, it was decided to run a second test on the same zone. D.S.T. No. 5 considered failure.

D.S.T. No. 6 through perforations 6,876 feet to 6,895 feet, 6,855 feet to 6,865 feet, 6,830 feet to 6,850 feet, and 6,810 feet to 6,820 feet.

The Howco test tool was run and packer set at 6,790 feet. Three-eighth-in. by. ¼-in. chokes. No water cushion. Tool was opened at 6.40 p.m.

Time.	Pressure.	Remarks.
1 minute	Blow	Immediate blow
5 minutes	Blow increasing	
10 minutes	¼ p.s.i. estimate	
15 minutes	½ p.s.i. estimate	
60 minutes	Blow decreasing	
90 minutes	Blow decreasing	
160 minutes	Blow getting stronger	
180 minutes	2 p.s.i. estimate	
205 minutes	8 p.s.i.	
240 minutes	14 p.s.i.	Maximum pressure
260 minutes	12 p.s.i.	Gas to surface
300 minutes	9 p.s.i.	
360 minutes	5 p.s.i.	
420 minutes	1 p.s.i.	
450 minutes	Less than 1 p.s.i.	Tool closed in

Tool closed in for 2 hours until 4.10 a.m., 19th November.

IFP 450 p.s.i.; FFP 2,775 p.s.i.; SIP 3,000 p.s.i.; MP 3,850 p.s.i.; FMP 3,725 p.s.i.

Recovery: 6,050 feet salt water and 200 feet drilling mud. Chlorides of salt water—3,550 p.p.m. A gas sample was taken from the bubble tube and was run though the Core Lab. gas system. The results indicate this gas contained 20 per cent. gases heavier than methane and 50 per cent. methane (with possible 0 to 30 per cent. inerts). As an explanation of this gas analysis, the Core Lab. unit will only read as high as 50 per cent. methane; therefore, as a maximum, this gas could be 80 per cent. methane and 20 per cent. heavier gases, depending on what percentage of inerts are present.

The zone 6,810 feet to 6,895 feet is shown by this test to be salt water productive. The small volume of gas observed probably came from the coal section present in this zone from approximately 6,857 feet to 6,882 feet. There was no evidence of oil on this test.

D.S.T. No. 7 through perforations 5,495 feet to 5,515 feet.

Ran Howco test tool. Packer set at 5,465 feet. Three-eighth-in. by ¼-in. chokes. No water cushion. Tool open at 2.45 p.m. Tool was open 4 hours and closed 2 hours.

Time.	Pressure.	Remarks.
Tool open	Good blow	
15 minutes	5 p.s.i.	
30 minutes	38 p.s.i.	
45 minutes	85 p.s.i.	Maximum pressure
60 minutes	65 p.s.i.	
70 minutes		Gas to surface (sample taken)
75 minutes	25 p.s.i.	
82 minutes		Well died
88 minutes		Water to surface

Time.	Pressure.	Remarks.
120 minutes	5 p.s.i.	Flowing water and drilling mud
135 minutes	10 p.s.i.	Flowing water into pit
150 minutes	18 p.s.i.	Flowing water
165 minutes	20 p.s.i.	Flowing estimate 18 b.p.h. water
180 minutes	25 p.s.i.	Flowing estimate 18 b.p.h. water
195 minutes	25 p.s.i.	Flowing estimate 18 b.p.h. water
210 minutes	25 p.s.i.	Flowing estimate 18 b.p.h. water
225 minutes	25 p.s.i.	Flowing estimate 18 b.p.h. water
240 minutes	28 p.s.i.	Shut in well

IFP 850 p.s.i.; FFP 2,425 p.s.i.; SIP—shut in valve did not close because of junk in valve; IMP and FMP 3,075 p.s.i.

Recovery: well flowed salt water at approximately 18 barrels per hour. Chlorides of water—2,900 p.p.m. A gas sample was taken at the bubble tube and run through the Core Lab. detector system. Results showed this gas to contain 8 per cent. heavier than methane and 50 per cent. methane.

The test shows this sand to be salt water productive. There was evidence of gas in the flowing water; however, it was of a very small volume and no gauge of volume was possible.

D.S.T. No. 8 through perforations 5,040 feet to 5,050 feet.

Ran Howco test tool. Three-eighth-in. by ¼-in. chokes. No water cushion. Packer set at 5,018 feet. Tool open at 12.15 a.m. Tool open for for 2 hours and closed in for 2 hours.

Time.	Pressure.	Remarks.
Tool open	Blow	Immediate blow
5 minutes	½ p.s.i.	Estimated
10 minutes	Slight increase	
15 minutes	5 p.s.i.	
30 minutes	14 p.s.i.	
45 minutes	28 p.s.i.	
50 minutes	42 p.s.i.	
55 minutes	60 p.s.i.	
60 minutes	69 p.s.i.	
68 minutes	75 p.s.i.	Maximum pressure
70 minutes	74 p.s.i.	
75 minutes	61 p.s.i.	
85 minutes	27 p.s.i.	
90 minutes	15 p.s.i.	Gas to surface (sample taken)
95 minutes	1 p.s.i.	Estimated
100 minutes		Mud surface
120 minutes		Flowing small volume mud
		Well shut in 2.15 a.m., 23rd November

IFP 150 p.s.i.; FFP 2,250 p.s.i.; SIP—no build up on chart, although the well stopped flowing as closed in valve was closed. It is believed that the actual shut in pressure is approximately equal to the FFP of 2,250 p.s.i., probably not being more than 100 p.s.i. higher. IMP 2,850 p.s.i. FMP 2,790 p.s.i.

Recovery: well flowed salt water to surface. Chlorides of water—2,400 p.p.m. A sample of gas was taken and run through the Core Lab. gas detector. The results indicate that this gas contains 8 per cent. heavier than methane and 50 per cent. methane. Again, it should be pointed out that this gas, while it could not contain more than 8 per cent. heavier gas, could contain as high as 92 per cent. methane, according to the percentage of inerts present which are not obtainable at the rig site.

The test shows this sand to be salt water productive, with a minute show of gas, possibly coming from lignitic sections.

D.S.T. No. 9 through perforations 4,775 feet to 4,795 feet.

Went in hole with Howco test tool. Three-eighth-in. by ¼-in. chokes. No water cushion. Packer set at 4,747 feet. Tool open at 5.00 a.m. for 2½ hours. Tool shut in at 7.30 a.m. for 2 hours.

Time.	Pressure.	Remarks.
Tool open	Blow	Immediate blow
5 minutes	½ p.s.i. (estimate)	
10 minutes	½ p.s.i. (estimate)	
15 minutes	2 p.s.i.	
30 minutes	8 p.s.i.	
40 minutes	11 p.s.i.	
45 minutes	14 p.s.i.	
60 minutes	23 p.s.i.	
90 minutes	56 p.s.i.	
105 minutes	73 p.s.i.	
120 minutes	81 p.s.i.	Maximum pressure
135 minutes	79 p.s.i.	
150 minutes	73 p.s.i.	Well shut in

IFP 150 p.s.i.; FFP 2,100 p.s.i.; SIP 2,100 p.s.i.; IM 2,700 p.s.i.; FM 2,690 p.s.i.

Recovery: 245 feet drilling mud and 4,232 feet salt water. It has now been determined that the shut in pressure and final flow pressure are approximate. In effect, the well shuts itself in when the hydrostatic head reaches a static level. No gas was noticed on this test. The chlorides of the water were checked at 2,250 p.p.m.

While this sand was salt water productive, it indicated a zone of less permeability than previous sands, in that it did not flow at the surface. There was no indication of any hydrocarbons on this test.

D.S.T. No. 10 through perforations 4,390 feet to 4,400 feet.

Went in hole with Howco test tool. Three-eighth-in. by ¼-in. chokes. No water cushion. Packer set at 4,376 feet. Tool open 11.20 a.m. for 3 hours 45 minutes. Tool closed 3.05 p.m. for 1 hour.

Time.	Pressure.	Remarks.
Tool open	Blow	Immediate blow
1 minute	½ p.s.i. (estimate)	
5 minutes	½ p.s.i. (estimate)	Slight increase
10 minutes	5 p.s.i.	
15 minutes	8 p.s.i.	
25 minutes	25 p.s.i.	
45 minutes	72 p.s.i.	
50 minutes	91 p.s.i.	
55 minutes	101 p.s.i.	
57 minutes	102 p.s.i.	
60 minutes	100 p.s.i.	Maximum pressure
65 minutes	93 p.s.i.	
70 minutes	85 p.s.i.	Gas to surface but flare would not burn
80 minutes	71 p.s.i.	
85 minutes	62 p.s.i.	
115 minutes		
225 minutes	7 p.s.i.	Water and mud to surface Well flowed salt water until shut in at 3.05 p.m.

IFP 0 to 80 p.s.i.; FFP 1,950 p.s.i.; SIP 1,950 p.s.i.; IMP 2,500 p.s.i.; FMP 2,450 p.s.i.

APPENDIX 6—*continued.*

Recovery: well flowed salt water at the estimated rate of seven barrels per hour on ¼-in. choke. The estimated chloride content is 2,500 p.p.m. A sample at the first of the test was weighed on a mud balance and showed a weight of 9.3 lb. per gallon. A sample at the end of the test was found to weigh the same. A small amount of gas was detected on this test, but it would not burn at the bubble tube. However, at the end of the test a small volume would burn at the flare line. This was a very small volume, which would only be regarded as a blow of gas on a test.

It was felt that this test was indicative of a good primary cement job and that the salt water recovered was representative of the water sand perforated. Also the amount of gas present was a volume representative of that recovered on other water tests in this well, and also similar to the artesian well completed at Betoota, Queensland.

By Authority: A. J. ARTHUR, Commonwealth Government Printer, Canberra.

DELHI - FROME - SANTOS

PETROLEUM TENEMENT: O.E.L. **20 & 21**

WELL NUMBER: INNAMINCKA No. 1

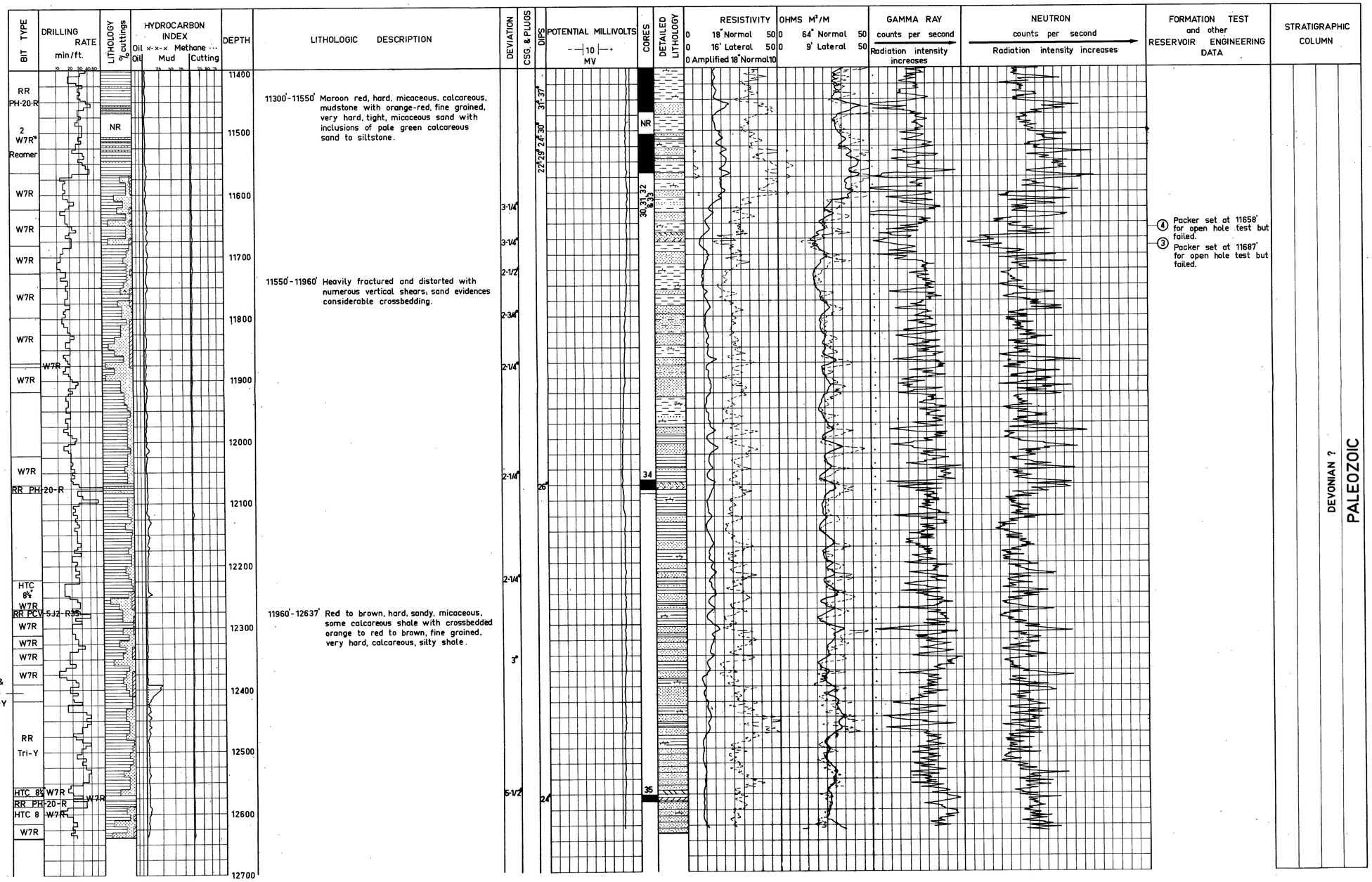
WELL SYMBOLS

- Core, interval, number and recovery.
- Sidewall core.
- Perforated interval.
- Formation test, interval and number.
- Plugged interval.

RR Re-run bit.

LITHOLOGIC REFERENCE

Conglomerate	Shale	Calcareous
Siltstone	Limestone	Unconformity
Claystone	Coal	Quartz Sand
Sand	Quartz	Gypsum



DELHI - FROME - SANTOS

PETROLEUM TENEMENT: O.E.L. 20 & 21

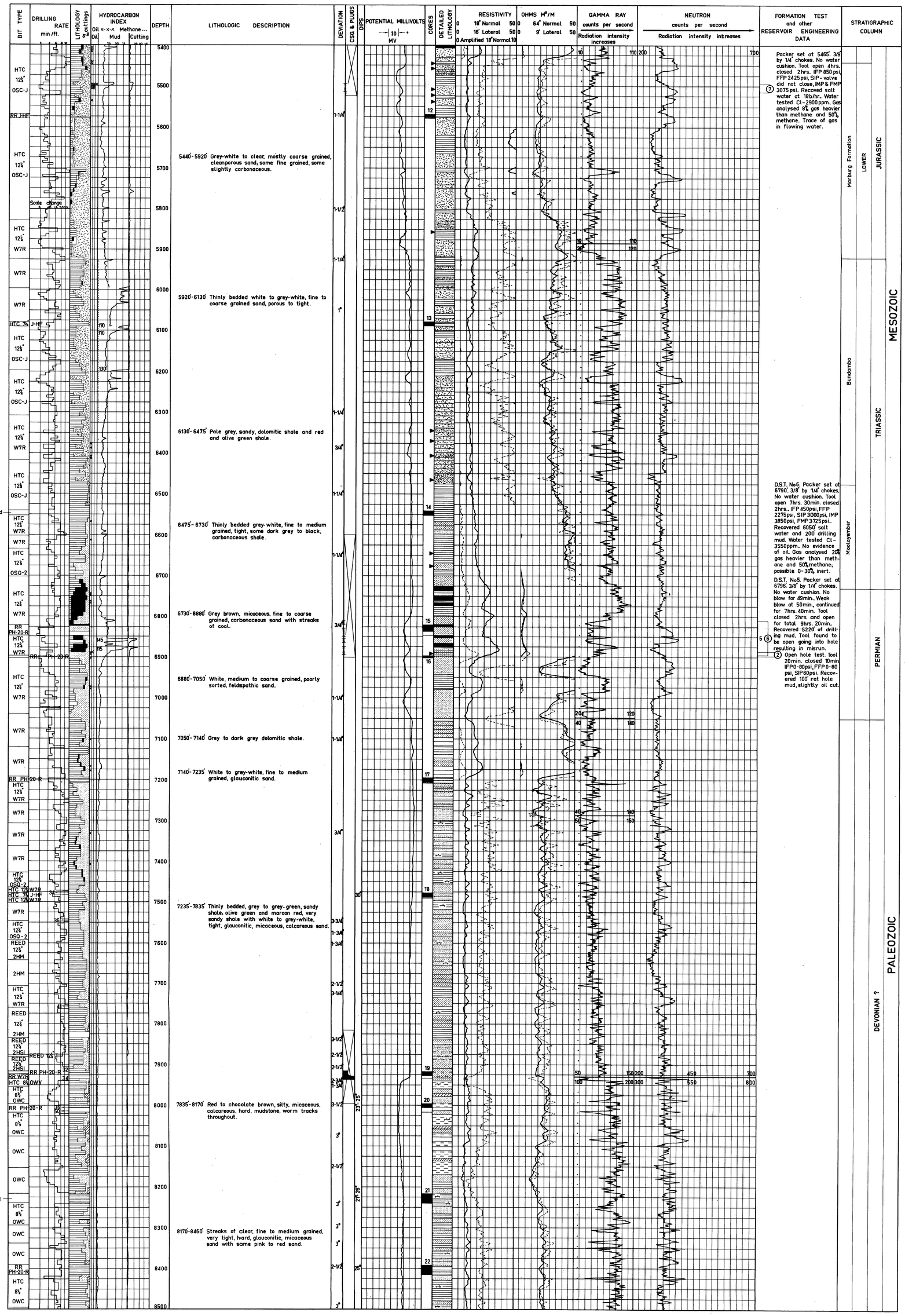
WELL NUMBER: INNAMINCKA No. 1

WELL SYMBOLS

- Core, interval, number and recovery.
- Sidewall core.
- Perforated interval.
- Formation test, interval and number.
- Plugged interval.
- RR Re-run bit.

LITHOLOGIC REFERENCE

- Conglomerate
- Siltstone
- Claystone
- Sand
- Shale
- Limestone
- Coal
- Quartz
- Calcareous
- Unconformity
- Quartz Sand
- Gypsum



DELHI - FROME - SANTOS

PETROLEUM TENEMENT: O.E.L. 20 & 21

WELL NUMBER: INNAMINCKA No. 1

WELL SYMBOLS

- Core, interval, number and recovery.
- Sidewall core.
- Perforated interval.
- Formation test, interval and number.
- Plugged interval.
- RR Re-run bit.

LITHOLOGIC REFERENCE

- Conglomerate
- Siltstone
- Claystone
- Sand
- Shale
- Limestone
- Coal
- Quartz
- Calcareous
- Unconformity
- Quartz Sand
- Gypsum

BIT TYPE | DRILLING RATE min/ft. | LITHOLOGY % cuttings | HYDROCARBON INDEX Oil x-x-x Methane··· Oil / Mud / Cutting | DEPTH | LITHOLOGIC DESCRIPTION | DEVIATION | CSG. & PLUGS | DIPS | POTENTIAL MILLIVOLTS | CORES | DETAILED LITHOLOGY | RESISTIVITY 0 18" Normal 20 / 0 16" Lateral 20 / 0 Amplified 18" Normal 4 | OHMS M²/M 0 64" Normal 20 / 0 9' Lateral 20 | GAMMA RAY counts per second / Radiation intensity increases | NEUTRON counts per second / Radiation intensity increases | FORMATION TEST and other RESERVOIR ENGINEERING DATA | STRATIGRAPHIC COLUMN

BIT TYPE:
- HTC 7¾ J-HF — 2508'-3018' H.T.C. 12¼" OSC-J Pilot hole
- HTC 7¾ J-SF — 3018'-3526' H.T.C. 12¼" OSC-J Pilot hole
- RR J-SF — 3526'-3937' H.T.C. 12¼" OSC Pilot hole
- RR J-HF — 3937'-4042' H.T.C. 12¼ OSC-3 Pilot hole
- HTC 7¾ J-SF — 3576'-4015' H.T.C. 17½" OWS Reamer
- HTC 12¼" OSC-J
- HTC 12¼" OSC-J
- RR J-SF
- HTC 12¼" OWS
- HTC 12¼" OWS
- HTC 12¼" OWS
- RR J-HF
- HTC 12¼" OWS-J
- HTC 12¼" OWS
- HTC 12¼" OSC-J

Scale change

DEPTH: 2400, 2500, 2600, 2700, 2800, 2900, 3000, 3100, 3200, 3300, 3400, 3500, 3600, 3700, 3800, 3900, 4000, 4100, 4200, 4300, 4400, 4500, 4600, 4700, 4800, 4900, 5000, 5100, 5200, 5300, 5400, 5500

2265'-2660' Traces of brown to grey dense limestone.

2660'-3380' Grey hard calcareous shale.

3380'-3890' Grey, hard, calcareous, some pyritic shale, some very fine grained glauconitic sand.

3890'-4080' Light grey to pink, hard, calcareous, shaly sand.

4080'-4225' Light grey to grey silty shale.

4225'-4395' Grey, fine grained, hard, tight sand.

4395'-4670' Brown-grey to clear, fine to coarse grained, poorly sorted, angular to subangular sand; some porous, some shaly.

4670'-5150' Light grey-white, fine to coarse grained, clean to shaly sand, some micaceous sand.

5150'-5440' Thinly bedded, fine to medium grained micaceous, carbonaceous sand with grey to dark grey carbonaceous shale.

DEVIATION: 1-1/2°, 1°, 1-1/2°, 1-1/4°, 1-3/4°, 1°, 1-1/2°, 3/4°, 1-1/4°, 2°, 1°

CSG. & PLUGS: 120'

DIPS: 10 MV

CORES: 5, 6, 7, 8, 9, 10, 11

RESISTIVITY: 0 18" Normal 200 / 0 16" Lateral 200 / 0 Amplified 18" Normal 4

OHMS M²/M: 0 64" Normal 20 / 0 9' Lateral 20

Scale change: 0 18" Normal 500 / 16" Lateral 500 / 18" Amp. Nor. 10 — 0 64" Normal 50 / 9' Lateral 50

GAMMA RAY: counts per second / Radiation intensity increases — 10 … 110

NEUTRON: counts per second / Radiation intensity increases — 200 … 700

(10) Packer set at 4376' 3/8" by 1/4" chokes. No water cushion. Tool open 3hrs. 45min. and closed 1hr.. IFP 0-80psi, FFP 1950psi, SIP 1950psi, IMP 2500psi, FMP 2450psi. Recovered salt water at 7½/hr. Water tested Cl-2500 ppm.. Trace of gas detected.

Packer set at 4747' 3/8" by 1/4" chokes. No water cushion. Tool open 2hrs. 30min. and closed 2hrs. IFP 150psi, FFP 2100psi, SIP 2100psi, IMP 2700psi, FMP 2690psi. Recovered 245' drilling mud and 4323' salt water. Water tested Cl- 2250 ppm. No hydrocarbons detected.

(9) (1) Open hole test. Tool open 30min. Had immediate weak blow remaining througout test. Recovered 20' slightly oil and gas cut mud. I&FMP 2500psi, I&FFP 0-80 psi, no SIP recorded

Packer set at 5018' 3/8" by 1/4" chokes. No water cushion. Tool open 2hrs. and closed 2hrs. IFP 150psi, FFP 2250psi, SIP approx.= FFP of 2250psi, IMP 2850psi, FMP 2790psi. Recovered salt water flow to surface. Water tested Cl-2400ppm. Gas analysed 8% gas heavier than methane and 50% methane.

STRATIGRAPHIC COLUMN

- Tambo — ALBIAN
- Roma — APTIAN
- CRETACEOUS
- Blythesdale Group — NEOCOMIAN
- UPPER
- MESOZOIC
- Walloon Coal Measures — MIDDLE
- JURASSIC

DELHI - FROME - SANTOS

PETROLEUM TENEMENT: O.E.L. 20 & 21 — WELL NUMBER: INNAMINCKA No.1

STATE: SOUTH AUSTRALIA — 4 MILE SHEET: INNAMINCKA — BASIN: GREAT ARTESIAN — WELL STATUS: ARTESIAN WATER BORE

LOCATION: Lat. 27° 29' 21·3"S Long. 140° 55' 07·7"E
ELEVATION: Reference Pt. (R.T.) 412·68' A.S.L.
Ground 401·68' A.S.L.

Date Spudded: 28th March 1959
Date Drilling Stopped: 16th November 1959
Date Rig Off: Rigging Down 28th November 1959
Total Depth: 12637'

Hole Size:

In.	From	To
27"	0'	231'
17½"	231'	4021'
12¼"	4021'	7935'
8¾"	7935'	12637'

Casing:

In.	Wt.	Gr.	Depth	Cmt.	Cmt. To
20"	94	H40	228'	400	Surface
13⅜"	54·5	J55	4018'	3250	"
9⅝"	43·5	N80	7935'	2000	4180'

Cement Plugs:

From	To	Top	Sacks
4665'	4800'	4700'	50
4920'	5055'	4925'	50
5390'	5525'	5388'	50
6635'	6900'	6800'	100
7837'	7995'	7815'	65
7780'	8050'	Did not hold	100

Perforations:

Type	Size	From	To	No/Ft.
Dynojet	0·59"	4390'	4400'	4
"	"	4465'	4475'	"
"	"	4550'	4560'	"
"	"	4775'	4795'	"
"	"	5040'	5050'	"
"	"	5495'	5515'	"
"	"	6810'	6820'	"
"	"	6830'	6850'	"
"	"	6855'	6865'	"
"	"	6875'	6895'	"

Well Head Fittings: 5½" Casing collar with 4" valve.
Drilled by: Delta Drilling Co.
Drilling Method: Rotary

ELECTRIC LOG DATA

Run No.	1	2	3	4	5	6	7	8	9	10
Date	7/4/59	21/4/59	18/5/59	13/7/59	3/8/59	8/9/59	19/9/59	13/10/59	3/11/59	15/11/59
Footage Logged	17'-...	2224	2067	1922	736	1600	511	967	806	264
Total Depth Electric Log	20'-1	4025	6081	7933	8670	10236	10712	11618	12387	12635
Total Depth Driller	2044	4048	6079	7933	8665	10238	10713	11622	12391	12637
Casing Shoe Elec. Log	227		4013		7933					
Casing Shoe Driller	230	230	4018	4018	7934	7934	7934	7934	7934	7934
Bit Size	17½ to 602	17½ to 2080	12¼	12¼	8¾	8¾	8¾	8¾	8¾	8¾
	12¼ to T.D.	12¼ to 4048								
Mud Data – Type	Native	Water Base Gel, Caustic Quebracho.	Water Base Gel, Caustic Myrtan.	Water Base	Water Base Lime,Gel, Myrtan, Caustic.	Water Base Lime, Gel	Water Base Lime,Gel,Myrtan, Caustic.	Water Base Gel, Myrtan	Water Base Gel, Myrtan, Caustic.	Water Base Gel,Myrtan, Caustic.
Weight	9·8	9·9	10·3	10·4	10·3	10·5	10·6	10·5	10·4	10·5
Viscosity	37	50	52	45	37	55	47	50	55	50
pH	7·0	10·5	10·5	10·3	12·5	11·5	11·8	11·5	11·5	11·5
Water Loss cc/30min.	65	16·2	11·4	10	12	19	20	15	15	17
Resistivity	1·2 /85° F	·95/90° F	·93/90° F	·75/90° F	·93/85° F	·50/85° F	·57/85° F	·50/100° F	·64/90° F	·64/90° F
Res./Max. Hole Temp.			·52/184° F	·40/183° F	·.../220° F	·21/228° F	·23/244° F	·22/264° F	·25/280° F	·25/280° F
Electrode Spacing	18"	18"	18"	18"	18"	18"	18"	18"	18"	18"
	64"	64"	64"	64"	64"	64"	64"	64"	64"	64"
	9"	9"	9"	9"	9"	9"	9"	9"	9"	9"
	16"	16"	16"	16"	16"	16"	16"	16"	16"	16"
Recorded by	Walker	Walker	Walker	Walker	Walker	Walker	Walker	Walker	Walker	Walker

RADIOMETRIC LOG DATA

Type of Log	Gamma – Neutron						
Run No.	1	2	3	4	5	6	7
Date	3/8/59	8/9/59	19/9/59	4/10/59	13/10/59	3/11/59	15/11/59
Total Depth Driller	8665	10238	10713	11398	11622	12391	12637
Top Logged Interval	100	8600	10200	10650	11350	11580	12350
Bottom Logged Interval	8666	10235	10711	11394	11620	12386	12636
Type Fluid In Hole	Mud	Mud	Mud	Mud	Mud	Mud	Mud
Fluid Level	Full	Full	Full	Full	Full	Full	Full
Max. Recorded Temp.	220° F	238° F	244° F	260° F	264° F	280° F	280° F
Neutron Source	Rad. Beryllium	Rad. Beryllium	Rad. Beryllium	Rad. Beryllium	Rad. Beryllium	Rad. Beryllium	Rad. Beryllium
" Strength	400mg.	400mg.	400mg.	400mg.	400mg.	400mg.	400mg.
Source Spacing	18"	18"	18"	18"	18"	18"	18"
Length Measure Device	G 28", N14"	G 28", N14"	G 28", N14"	G 28", N14"	G 28", N14"	G 28", N14"	G 28", N14"
O.D. of Instrument	3⅜"	3⅜"	3⅜"	3⅜"	3⅜"	3⅜"	3⅜"
Time Constant – sec.	2-2	2-2	2-2	2-2	2-2	2-2	2-2
Logging Speed ft/min.	24	24	24	24	24	24	24
Sensitivity Reference	100/500	100/500	100/500	100/500	100/500	100/500	100/500
Recorded by	Walker	Walker	Walker	Walker	Walker	Walker	Walker

CASING RECORD

Run	Size – In.	Wt – Lbs.	From	To
	20"	94	0'	230'
	13⅜"	54·5		4018'
	9⅝"	43·5		7934'

OPEN HOLE RECORD

Bit Size – In.	Interval
8¾"	7935' – 12637'

WELL SYMBOLS

- Core, interval, number and recovery.
- Sidewall core.
- Perforated interval.
- Formation test, interval and number.
- Plugged interval.
- RR Re-run bit.

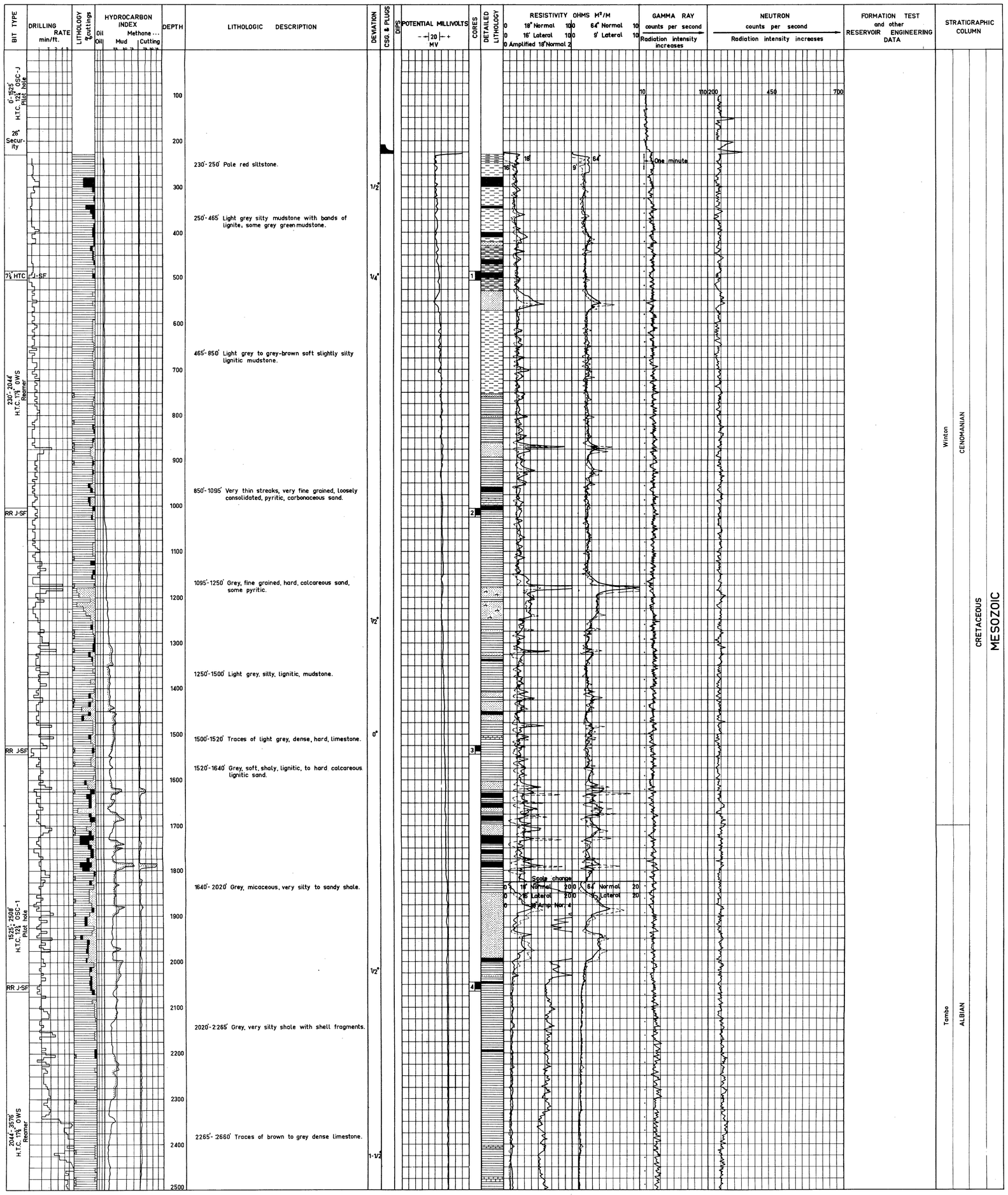
LITHOLOGIC REFERENCE

Conglomerate, Siltstone, Claystone, Sand, Shale, Limestone, Coal, Quartz, Calcareous, Unconformity, Quartz Sand, Gypsum

OTHER ELECTRICAL LOGS

TEMPERATURE	200'-7900'
GUARD	7932'-12634'
CALIPER	229'-12637'
DIP	7931'-12635'

LITHOLOGY BY: J. C. Ryan
COMPILED BY: J. H. Allen
DELHI AUSTRALIAN PETROLEUM LIMITED



DELHI - FROME - SANTOS

PETROLEUM TENEMENT: O.E.L. 20 & 21

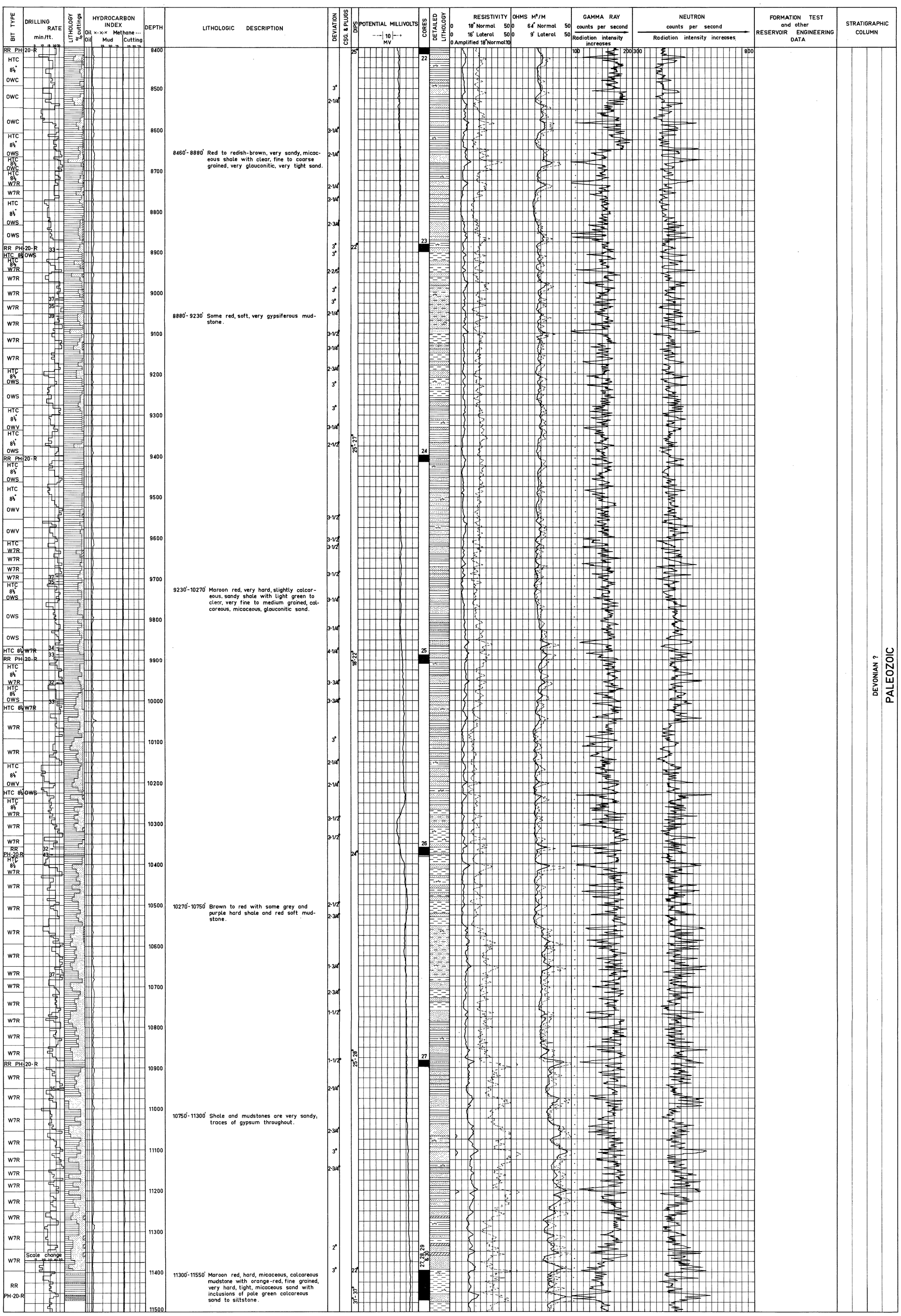
WELL NUMBER: INNAMINCKA No. 1

WELL SYMBOLS

- Core, interval, number and recovery.
- Sidewall core.
- Perforated interval.
- Formation test, interval and number.
- Plugged interval.
- RR Re-run bit.

LITHOLOGIC REFERENCE

- Conglomerate
- Shale
- Calcareous
- Siltstone
- Limestone
- Unconformity
- Claystone
- Coal
- Quartz Sand
- Sand
- Quartz
- Gypsum



DELHI - FROME - SANTOS
SOUTH AUSTRALIA

STRATIGRAPHIC COLUMN

INNAMINCKA Nº 1

Latitude : 27° 29' 21·3" South

Longitude : 140° 55' 07·7" West

Elevation : 401·68 Ground

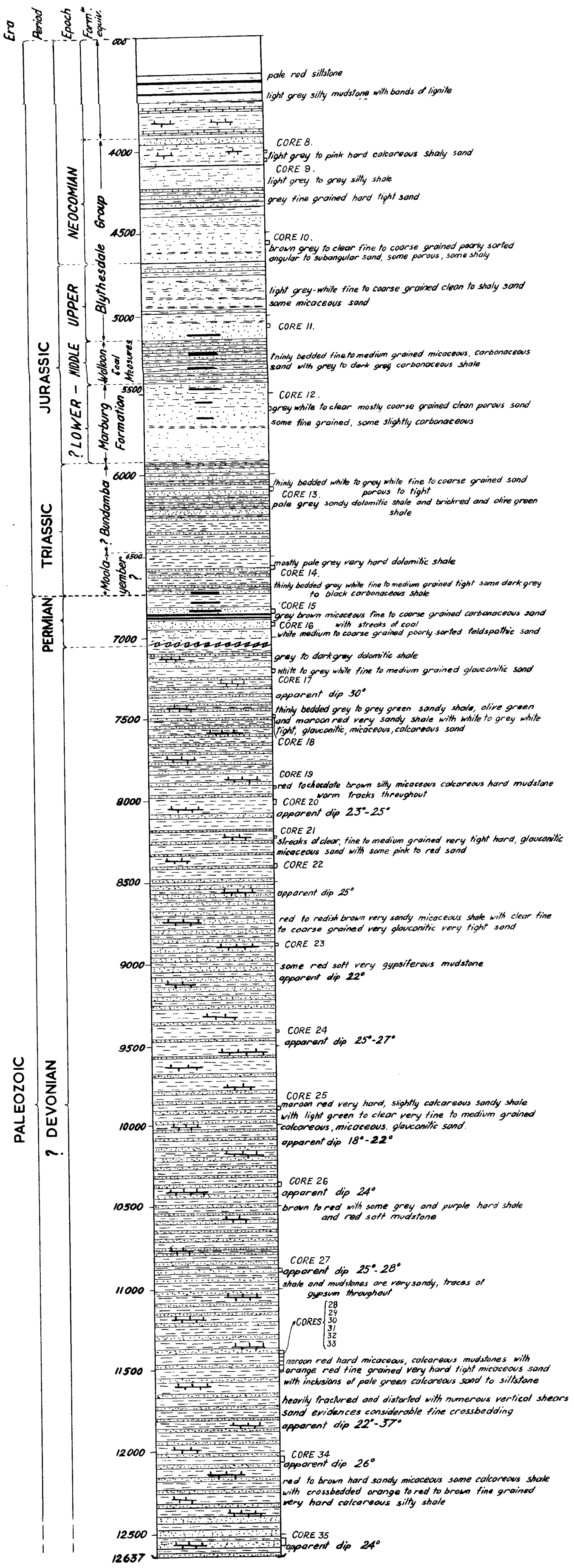
Date : 12 - 12 - 1959.

Total depth : 12 637 ft

Lithology by John C. Ryan

Vertical scale : 1in = 500 ft

Paleo reference for Time & Time - Rock - Units by Dr. N. Ludbrook



ENCLOSURE 3

140° 30′ 141° 00′ 141° 30′

27° 00′ 27° 30′ 28° 00′

SOUTH AUSTRALIA

QUEENSLAND

LAKE PURE

Candradreeka Creek

Patchewarra Creek

Merrinie Ck

Cooper Creek

Strzelecki Creek

INNAMINCKA No1

Innamincka H.S.

Nappamerry H.S.

Qrt

Qrs

K

Tsi

T

LEGEND

QUARTERNARY

- Qrs — Alluvium outwash plains, interdunal area.
- Qrt — Gibbers, gibber outwash, gibber terraces, talus slopes.

TERTIARY

- T — Undifferentiated Tertiary.
- Tsi — Siliceous duricrust.
- Qrt/T — Gibbers over Tertiary.

CRETACEOUS

- K — Undifferentiated Cretaceous.
- Qrt/K — Gibbers over Cretaceous shales limestones.
- T/K — Tertiary over Cretaceous shales.

Scale

4 3 2 1 0 4 8 12 miles

Drawn by J Allen

DELHI AUSTRALIAN PETROLEUM LIMITED

REGIONAL GEOLOGIC MAP OF THE INNAMINCKA ANTICLINE

GREAT ARTESIAN BASIN

AUSTRALIA