C O N F I D E N T I A L

WELL COMPLETION REPORT

PHILLIPS 7/11-3X

PRODUCTION LICENSE 018

WELL COMPLETION REPORT
PHILLIPS 7/11-3X
PRODUCTION LICENSE 018

C O N T E N T S

SUMMARY

Well:	Phillips 7/11-3X.
Classification:	Dry Step-out Well.
Area:	Field 7, Block 11, Production License 018
Contractor and Rig:	ODECO Norway Inc., "Ocean Traveler"
Location:	Line P 022830, Shotpoint 73, 57° 02' 58.8" N., 02° 28' 18.8" E.
Water Depth:	79 meters (260 feet) below mean sea level
Rotary Kelly Bushing:	26.5 meters (87 feet) above mean sea level
Objective:	To test the Paleocene
Results:	Tested water, with some gas and condensate from Paleocene
Status:	Plugged and abandoned.
Total Depth:	3350 meters (10992 feet)

DRILLING HISTORY

Dates of Operations

Spud:	17 October 1968
At Total Depth:	29 November 1968
Completed:	7 January 1969

Details of Operations

- Casing Program -

20-inch set at 172 meters RKB (563 feet) in 26-inch hole with 1000 sacks of cement.

13 3/8-inch set at 496 meters RKB (1627 feet) in 17½-inch hole with 700 sacks of cement.

9 5/8-inch set at 1972 meters RKB (6471 feet) in 12 1/4-inch hole with 800 sacks of cement.

7-inch set at 3341 meters RKB (10960 feet) with 750 sacks of cement.

- Mud Program -

Depth:	Weight (ppg)	Viscosity	Pv	Yp	Water Loss
0 - 1675 feet (0 - 510 meters)	8.8	100	-	-	-
1675 - 6540 feet (510 - 1933 meters)	12.0	53	39	12	5.2
6540 - 7540 feet (1933 - 2298 meters)	12.9	50	35	15	5
7540 - 8400 feet (2298 - 2560 meters)	14.5	60	50	10	4
8400 - 9600 feet (2560 - 2926 meters)	14.0	60	50	10	5
9600 - 10992 feet (2926 - 3350 meters)	13.9	50	35	14	5

Seawater was used for drilling to 3800 feet at which depth the system was changed to a Drispac-Flosal-Desco type. From 6540 feet to total depth a sodium chloride-saturated Drisco-Flosal-Desco system was used.

- Logging Program -

Schlumberger Tools:	Run:	Interval:
Induction Electric	1	6469 - 10993 feet
Gamma Ray/Sonic-Caliper	1	1621 - 5829 feet Gamma Ray to subsea
	2	5600 - 6539 feet
	3	6470 - 10990 "
Laterolog	1	9600 - 10991 feet
Microlaterlog/Microlog-Caliper	1	9600 - 10992 feet
Formation Density	1	9600 - 10820 feet
	-	10930 - 10991 "
Neutron	1	9600 - 10820 feet
Continuous Dipmeter	1	6471 - 10986 feet
Cement Bond (Gamma Ray-Casing Collar Locator)	1	6400 - 10798 feet

- Drilling Problems -

Minor trouble with sloughing shale occurred in the section above 6400 feet before the 9 5/8-inch casing was set. The most troublesome shale section was encountered between 6400 and 7540 feet in which hole collapse and intermittent bridging took place until mud weight was increased from 12.9 to 14.5 ppg.

- Hole Deviation -

Maximum vertical deviation reached 3° at 7060 feet and returned to 0° at total depth.

- Stuck Pipe -

Insignificant sticking occurred between 2700 and 5972 feet where the hole wall fell in unconsolidated section.

- Lost Circulation -

No lost circulation problems occurred.

- Coring -

Three cores were taken in the Paleocene sandstone section:

Core No. 1: 10086 - 10101 feet, recovered 25 feet, 100%

Core No. 2: 10147 - 10192 feet, recovered 40 feet, 90%

Core No. 3: 10369 - 10424 feet, recovered 55 feet, 100%

Core descriptions are covered in Appendix 1, and core analyses in Appendix 2.

- Testing -

Eight drill stem tests were made with the following results:

DST No. 1, 10629 - 10651' (22' perforated): IF 19 min, ISI 5 hrs 15 min, FF 4 hrs, FSI 4 hrs 2 min. Reversed out 88 bbls of formation water contaminated with diesel oil, mud and mud filtrate, and 4 bbls predominantly of diesel and mud. Lowest Cl^- 85,000 ppm. IFP_1 3885, IFP_2 3885, ISIP 5247, FFP_1 3910, FFP_2 3952, FSIP 5033.

DST No. 2, 10532 - 10603' (43' perforated): IF 15 min, ISI 3 hrs, FF 12 hrs 30 min, FSI 4 hrs 30 min. Reversed out 91 bbls: 60 bbls diesel, 5 bbls mud, 23 bbls water, 3 bbls contaminated mud. Lowest Cl^- 32,000 ppm. IFP_1 3925, IFP_2 3885, ISIP 5482, FFP_1 3942, FFP_2 4188, FSIP 5420.

DST No. 3, 10423 - 10506' (45' perforated): IF 15 min, ISI 2 hrs 55 min, FF 6 hrs 30 min, FSI 3 hrs 45 min. Reversed out 91 bbls: 78 bbls diesel, 3 bbls mud, 8 bbls water, 2 bbls water-cut mud. Lowest Cl^- 67,000 ppm. IFP_1 3950, IFP_2 3885, ISIP 5525, FFP_1 3926, FFP_2 4019, FSIP 5510.

DST No. 4, 10369 - 10408' (30' perforated): IF 15 min, ISI 2 hrs 30 min, FF 9 hrs 45 min, FSI 3 hrs 25 min. Reversed out 89 bbls: 65 bbls diesel, 5 bbls diesel-cut mud, 17 bbls water, 2 bbls water-cut mud. Lowest Cl^- 38,000 ppm. IFP_1 3825, IFP_2 3810, ISIP 5489, FFP_1 3800, FFP_2 4067, FSIP 5473.

DST No. 5, 10255 - 10315' (60 ' perforated): IF 16 min, ISI 5 hrs 9 min, FF 13 hrs 30 min, FSI 4 hrs 8 min. Reversed out 90 bbls: 66 bbls diesel, 5 bbls diesel-cut mud, 15 bbls water, 4 bbls water-cut mud. Lowest Cl^- 30,000 ppm. Stuck packer, unable to retrieve pressure recorder.

DST No. 6, 10158 - 10203' (45' perforated): IF 15 min, ISI 2 hrs 53 min, FF 3 hrs 53 min, FSI 2 hrs 49 min. Flowed at rate of 1032 BPD, recovered 154 bbls: 88 bbls diesel, 3 bbls diesel-cut mud, 56 bbls water, and reversed out 88 bbls water. Lowest Cl^- 18,500 ppm. IFP_1 3815, $FIFP_1$ 3943, ISIP 5513, IFP_2 4049, FFP_2 4491, FSIP 5331.

DST No. 7, 10125 - 10145' (20' perforated): IF 15 min, ISI 1 hr 48 min, FF 18 hrs 10 min. Flowed through ½" choke at rate of 120 MCFGPD, 90 BPD green-black 47° API oil, 340 BPD water lowest Cl^- 15,400 ppm. IFP_1 3734, $FIPP_1$ 3789, ISIP 5541, IFP_2 3832, FFP_2 3532, FSIP 5306.

DST No. 8, 9960 - 9990' (30' perforated): IF 15 min, ISI 2 hrs 57 min, FF 1 hr, FSI 1 hr 30 min. IFP_1 3647, $FIFP_2$ 3639, FFP_2 3644, FSIP 3906.

In this report the Paleocene is re-defined and divided into two formations and members according to correlations made between the three Cod wells: the Upper Paleocene Cod formation and the Lower Paleocene Danian unnamed limestone-sand-shale formation. The vertical distribution of tests in the Cod formation and comparison with those in the 7/11-1X and 2X wells is made under Prospect Geology, Test Results.

- Plugging and Abandonment -

The 7-inch casing was plugged as follows:

9990 - 9840 feet RKB:	Cement plug set above final perforations.
8749 feet RKB:	Set Baker Model M bridge plug.
5000 feet RKB:	Set Baker Model K cement retainer-bridge plug; squeezed 25 sacks cement into 7" - 9 5/8" annulus through perforations between 5015 - 5017 feet.

Casing was cut as follows:

370 feet RKB:	7-inch
365 feet RKB:	9 5/8-inch
349 feet RKB:	13 3/8-inch
340 feet RKB (sea floor):	20-inch

A cement plug was laid from sea floor to 640 feet RKB.

OBJECTIVES

The objectives of the 7/11-3X were to test the hydrocarbon potential of the Tertiary section, specifically the Paleocene sandstones productive in 7/11-1X and 7/11-2X, and the top of the Danian limestone.

Corolary objectives were to find a suspected oil ring and to establish the gas-water contact and the productive limits of the Cod Field.

GEOLOGY

Regional Geology

The Cod Field lies in the axis of the present-day maximum depression of Tertiary section as evidenced by structure mapped seismically on the base of the Tertiary (Figure 1). The Cod structure is one of an en-echelon series of slightly elongated salt-intruded anticlines which parallel the trend of the axis along its course. Most of the basinally central anticlines including Cod are intruded by Permian salt up to, or close to, the base of the Upper Cretaceous Chalk. Older sediments are not preserved over the crests of the salt intrusions except in basin flank positions at shallower Tertiary depths as, for example, the Amberjack structure on Block 16/11. The apparently significant coincidence of Paleocene producing sands at Cod with the axis of greatest Tertiary depression is referred to further in the concluding paragraphs under Stratigraphy.

Prospect Geology and Results

- Structure -

The Cod 7/11-3X well was drilled on the southeast flank of the structure, three kilometers due southeast of 7/11-1X. Geophysical reinterpretation of the structure, concurrent with the drilling of the well, resulted in a conception of increased areal closure on the top of the Paleocene as compared with the conception of the closure when 7/11-1X and 2X were drilled. Hydrocarbon-bearing closure, however, is less than total structural closure.

As the result of drilling two Cod wells, the horizon previously identified as "Green" (Base of Tertiary) was reidentified as the top of the Paleocene and re-named "Pink", and the previous "Yellow" (Base of Upper Cretaceous Chalk) was reidentified as "Green" (Base of Tertiary, or top of Upper Cretaceous Chalk). The dimensions of the structure, as presently interpreted are (see Figure 2 and 3):

Seismic Horizon	Stratigraphic Horizon	Area of Closure	Vertical Closure
"Pink"	Top Paleocene	17.8 mi^2	660'
"Green"	Near Base Tertiary-top Upper Cretaceous Chalk	7.5 mi^2	800-900'

Results of drill stem tests serve to restrict the size of the area containing hydrocarbons within Paleocene closure. These results put together with results of tests and log analyses on 7/11-1X and 7/11-2X further serve to present discrepancies in the apparent levels of gas-water contacts from well to well, not readily explainable by the present seismic structural interpretation. Variable gas-water contacts are entirely feasible, however, in view of evidence which indicates multiple reservoirs, discussed under Test Results. The hydrocarbon-bearing area of closure of the Cod structure, however, is taken as eight square miles, with water levels based on DST No. 7 in 7/11-3X and on log analysis in 7/11-2X. Seismic interpretations of faults, also, are of importance in regard to area of closure on the west half of the structure, and in regard to possible bearing on the apparently different depths of gas-water contacts on the east and west halves of the structure. These interpretations apply mainly to the principal north-south fault bisecting the structure on the Paleocene mapping horizon, but to some extent apply also to unmapped minor faults on the east side of the structure detectable on seismic lines NJV 5704 and PG 5704 of which one may intersect the 7/11-1X Paleocene section. Resolution of fault details may come about in further seismic mapping of the east and west flanks and of the north and south elongations of the Cod structure, currently in progress.

- Well Stratigraphy -

Stratigraphic Units:

Unit	Depth RKB Meters	Depth RKB Feet	Sea Level Meters	Sea Level Feet	Drilled Thickness Meters	Drilled Thickness Feet
QUATERNARY						
Recent	106	347	- 79	- 260	± 442	± 1453
Pleistocene						
TERTIARY						
Upper Pliocene	549	± 1800	- 522	- 1713	± 247	± 810
Lower Pliocene	796	2610	- 769	- 2523	73	240
Upper Miocene	869	2850	- 842	- 2763	71	232
Middle Miocene	939	3082	- 913	- 2995	661	2168
Lower Miocene						
Burdigalian	1600	5250	- 1574	- 5163	213	699
Aquitanian	1813	5949	- 1787	- 5862	259	849
Oligocene	2072	6798	- 2046	- 6711	741	2432
U?-M? Eocene	2813	9230	- 2787	- 9143	166	544
L?Eocene-?Paleocene	2979	9774	- 2953	- 9687	53	174
Paleocene	3032	9948	- 3006	- 9861	301	988
Lower Paleocene						
Danian	3333	10936	- 3307	-10849	17+	56+
(Total Depth)	3350	10992	- 3324	-10905	-	-

Lithology:

Quaternary

Recent-Pleistocene undifferentiated. Thickness ± 442 meters (± 1453 feet). This section was drilled without returns.

Tertiary

Upper Pliocene Clay Unit. Thickness ± 247 meters (± 810 feet). This unit consists of soft light grey clay with abundant shell fragments. Unconsolidated poorly sorted, subrounded coarse, medium and fine grained sand with traces of glauconite are interbedded with green-grey and light brown clay in the lower half. Thin beds of hard white silty limestone and limestone nodules appear in the lower quarter.

Lower Pliocene Clay Unit. Thickness 73 meters (240 feet). This unit consists of green-grey to light brown clay and minor beds of silt and silty sand, with traces of yellow chert, white limestone nodules and shell fragments.

Upper Miocene Clay Unit. Thickness 71 meters (232 feet). This unit is made up of soft light grey clay and silty clay, with a few thin interbeds of limestone, and traces of shell fragments.

Middle Miocene Clay Unit. Thickness 661 meters (2168 feet). The upper part of this unit is marked by a trace of light brown dolomitic limestone and fine sand, followed by soft light grey, grey-brown, white to light grey, and light brown to green clays composing the upper third of the unit, and thin beds of light brown limestone. This is followed by grey to dark grey clay with traces of lignite. Thin hard light brown to white limestone beds occur in the lower 600 feet within firm to soft, grey-brown to grey-green shale.

Lower Miocene Burdigalian Shale Unit. Thickness 213 meters (699 feet). This unit consists of medium hard to soft, grey, grey-brown, dark brown shale, in some beds silty, pyritic and carbonaceous. Traces of white siltstone, and white to light brown, occasionally sandy, limestone and crystalline limestone occur throughout.

Lower Miocene Aquitanian Shale Unit. Thickness 259 meters (849 feet). This unit consists of soft to medium hard brown to dark brown shale and light brown to red-brown clay with interbedded hard white to light brown microcrystalline limestone; traces of siltstone, and thin dolomite beds occur towards the base.

Oligocene Shale Unit. Thickness 741 meters (2432 feet). This unit consists of dark brown micaceous silty shale with thin interbedded white chalky limestone and traces of hard brown dolomite. Light grey to grey, soft gummy shales are interbedded with the dark shale. Pyrite is disseminated throughout.

Upper?-Middle? Eocene Shale Unit. Thickness 166 meters (544 feet). This unit consists of light grey to grey-green to brown firm and fissile, silty and sandy shale, in some places mottled, with considerable interbedded grey glauconitic siltstone. Brown to grey and sucrosic dolomite beds are common.

Lower? Eocene-?Paleocene Shale Unit. Thickness 53 meters (174 feet). This unit consists of light brown, white, and grey soft clayey shale with disseminated pyrite, and thin beds of brown dolomite and white chalky limestone. The basal 40 feet consists of very soft red-brown clay.

Upper Paleocene Cod Formation. Thickness 301 meters (988 feet). The upper 180 feet of this formation consist of grey to grey brown silty shale with thin white chalky limestones, light grey silty sandstone and silty shale. These are underlain by a continuous light grey to brown silty, very fine to fine, medium, and occasionally coarse grained micaceous sandstone, with grains commonly angular to subangular, and has a variably argillaceous or dolomitic matrix. Traces of glauconite, carbonaceous material, and quartz pebbles appear in places. The porous intervals of the sandstone are characterized by bleeding gas and light brown oil and stain, strong yellow fluorescence under ultraviolet light and cut in carbon tetra-chloride. Grey-brown to dark brown shale and silty shale are interbedded throughout, increasing in number of beds and thickness in the lower part of the section. One-to-three-foot thick, light brown to brown dense and white chalky, limestone beds occur at 25-to-50 foot intervals increasing in the lower part in number and in thickness to make up 50 percent of section, the remaining 50 percent consisting of sandstone and shale as above. The sandstone in the lower part is typically hard, calcareous and tight. Oil stains, however, are common.

Lower Paleocene Danian Limestone Unit. Thickness 17+ meters (56+ feet). This unit consists of white to light grey chalky and sandy limestone with thin streaks of grey shale, and traces of light brown translucent chert.

- Cod Anticline Stratigraphy -

The revision of subdivisions of the Cod formation made in the Well Completion Report on 7/11-2X is superceded by a further redefinition of the Paleocene in the report as a result of correlations of IES log resistive intervals between the three Cod wells. The Paleocene is divided into two formations, the Upper Paleocene Cod formation and the unnamed Lower Paleocene Danian formation. The Cod formation is dominantly sand and shale with minor limestone stringers, whereas the Danian is marked by dominant limestone or chalk and minor sand and shale. The Cod formation is subdivided into five members. Its principal hydrocarbon-bearing sand member, the Middle, is further subdivided into sand-shale units, according to the following correlations:

Cod Formation Subdivisions:

Members	7/11-2X RKB	S.L.	Thick	7/11-1X RKB	S.L.	Thick	7/11-3X RKB	S.L.	Thick
(Top Paleocene)	(9786)			(9427)			(9948)		21
Upper Sand	9786 -	9699	44	9427 -	9337	39	9969 -	9882	23
Shale	9830 -	9743	103	9466 -	9376	62	9992 -	9905	134
Middle Sand	9934 -	9847	269	9528 -	9438	281	10126 -	10039	296
Lower Sand B	10203 -	10116	241	9809 -	9719	167	10422 -	10335	229
Lower Sand A	10444 -	10357	120	9976 -	9886	102	?10651 -	10564	285
Total			777			651			988
(Danian)	(10564)		416	(10078)		310	(10936)	(est.)	114
Total Paleocene			1193			961		(est.)	1102
(Top U.Cret.)	(10980)			(10388)			(est. 11050)		

Middle Sand Member Subdivisions:

Unit	7/11-2X RKB	S.L.	Thick	7/11-1X RKB	S.L.	Thick	7/11-3X RKB	S.L.	Thick
VII		Missing	0		Missing	0	10126 -	10039	28
VI	9934 -	9847	28	9528 -	9438	26	10154 -	10067	23
V	9962 -	9875	46	9554 -	9464	37	10177 -	10090	27
IV	10008 -	9921	33	9591 -	9501	52	10204 -	10117	39
III	10041 -	9954	49	9643 -	9553	61	10243 -	10146	77
II	10090 -	10003	49	9704 -	9614	64	10320 -	10233	44
Ib	10139 -	10052	38	9768 -	9678	26	10364 -	10277	26
Ia	10177 -	10090	26	9794 -	9704	15	10390 -	10303	32
(Base)	10203 -	10116	-	9809 -	9719	-	10422 -	10335	-
Total			269			281			296

The foregoing are illustrated by IES log correlations (Figure 4). Comparison of the Cod formation in each well shows that it thickens on the flanks. Thickening, however, does not occur uniformly in each of the members. This is most apparent in the Upper Sand for which the component of thickening is westward, and in the Middle Sand for which the component of thickening is eastward. Although a similar generalization cannot be made for the unit subdivisions of the Middle Sand, interpretations of sedimentary studies on the cores recovered from the Middle Sand in each of the three wells are of possible application and provide possible explanation. These studies concluded that the sands of the Middle Member are typical turbidites. (See Appendix 3, this report; Appendices 3 and 4, Well Completion Report 7/11-2X.) As such the unit subdivisions, being comparatively small sets of lithology, cannot be expected to have uniformity in thickness although some uniformity in direction of deposition should be expected. This, however, does not seem to be the case, as discussed further below.

Prevailing directions of structural dips and depositional dips indicated by polar plots (Attachments) of lithologic members of the Paleocene are summarized graphically in Figures 5 - 10.

Structural dip from Danian up through ?L.Eocene-?Paleocene was remarkably conformable to the present structural position of each well on the Cod anticline, and reflects a continuous bowing up without lateral shifts of the salt dome below. Depositional dip orientation beginning with the Danian and up through the Middle Sand Member similarly was conformable to structural position with some exception as the prevailing direction is southward in the Danian. The uniformity in direction of depositional dip in the Cod formation members that would indicate the direction of source for which we are looking, is not evident. Directional conformity between structural dip and depositional dip indicates that the rising salt structure deflected and controlled the direction of deposition locally. Not until the Shale Member and the Upper Sand Member both of which were horizontally deposited, was there a cessation in structural rise and in preferred direction. The ?L.Eocene-?Paleocene like the Danian however, seems to have been deposited in a south-southwestward direction. Progressive changes with time of structural and depositional direction are indicated on Figures 10A and 10B, the oldest unit indicated by the shortest dip line and the youngest indicated by the longest dip line.

The source of the Middle Sand Member is of chief interest as this member contains the principal hydrocarbon reservoirs. Structural and depositional dip data in the intervals approximating the upper two-third (U) and the lower third (L) of the Middle Sand Member in the three wells are summarized as follows:

	7/11-2X		7/11-1X		7/11-3X	
Middle Sand Mem.	U	L	U	L	U	L
Depth Interval	9934'- 10080'	10080'- 10205'	9525'- 9695'	9695'- 9810'	10125'- 10310'	10310'- 10425'
Structural Bearing						
mean	225°	300°	100°	340°	80°	(none)
range	210-260°	270-320°	100-120°	315-15°	55-100°	-
Structural Dip	7°	5°	5°	3°	6°	0°
Depositional Bearing	280°	325°(?)	110°(?)	345°	105°	(none)

A graphic summary of the above tabulation is shown in Figures 7A and 7B.

In the lower third of the Middle Sand Member there is a suggestion of north-northwesterly deposition independent of the structural position of each well, but in the upper two-third there is an apparent relationship between direction of deposition and well location on the structure. Direction of deposition, in other words, was influenced locally by the shape of the structure as was the case with older Paleocene units. This unfortunately gives no basis for the postulation of direction of sand source nor of the best porosity facies in the sands. Hopefully, these may be realized with additional wells in the area like the planned Northeast Cod 7/11-4X. Nevertheless, as an initial working idea to pursue, the north-northwesterly direction of deposition of the lower third of the Middle Sand Member is taken to be representative of the Middle Sand, and a southward to southeastward source is postulated. The structural high on which the Phillips U.K. Blocks 30/29, 38/4,5 are located is the consequent initial choice for source. An ancient North Scottish source is suggested in the sedimentary study on cores (Appendix 3) but this locale is thought to be too far removed.

In the section on Regional Geology, reference was made to the fact that the Cod Field apparently coincides with the present-day maximum structural depression of Tertiary sediments, with the implication that greatest turbidite sand developments in the Paleocene producing section will naturally occupy maximum depressions. This coincidence, however, may be entirely fortuitous unless and until it can be demonstrated that the maximum depression of the basin during Paleocene time coincided with present-day depression. The effects on sand accumulations of salt domes possibly elevated on the subsea surface which was receiving deposition, locally obscure the regional picture. A possible approach to predict sand development exists in the seismic record sections. In the Cod area good reflection character appears but eastward, for example toward the Gulf 7/12-1X well, the reflection character becomes poorer and the thickness of the Paleocene becomes less. Shaling out of sands as well as thinning would seem to go hand in hand with loss of reflection strength. The lack of development of the Middle Sand Member in the relatively nearby Gulf 7/12-1X and Shell 1/3-1X wells, both occupying positions in the center of the basin (see Figure 1), are cases in point. With the data on hand, it cannot be said the best prospecting areas for the Paleocene lie in the axis of depression. Conversely, if the association of maximum sand development and thickness with axial depression is a fact, then similar sand development - axial depression associations can be expected in other Tertiary Stages such as the Eocene, Oligocene and Miocene, their locations being dependent upon the shift of basin axis in time. The absence of the Middle Sand Member as a sand in the Gulf 7/12-1X and Shell 1/3-1X wells may be due merely to non-deposition over rising salt domes, but approached from the Cod area there is also loss of reflection character in the Paleocene section to the Gulf 7/12-1X.

- Test Results -

General

Comparative intervals of the Cod formation members tested in each of the three Cod wells follow:

	7/11-2X	7/11-1X	7/11-3X
Upper Sand	DST 3	DST 5	DST 8
Shale Member	-	-	VII DST 7
Middle Sand	VI V IV III DST 2 II Ib Ia	VI V DST 4 IV III Ib DST 3	VI V DST 6 III DST 5 Ib Ia DST 4 Ia LSB DST 3
Lower Sand B	LSB DST 1	-	LSB DST 2 DST 1
Lower Sand A	LSA	-	-
Danian	-	DST 2 DST 1	-

Beginning with the Upper Sand Member and progressing down, conclusions from test results on the three wells indicate that at least six discrete reservoirs and accumulations have been demonstrated in the Cod structure on the basis of pressure plots, gravity of oil recoveries and salinity of waters recovered. Lateral pinchouts of stratigraphic units (Middle Sand, Units Ia and VII in 7/11-3X) and possible fault separations of reservoirs further serve to strengthen our belief that the Cod structure contains multiple separate reservoirs, a complicating factor in regard to calculation of reserves.

Upper Sand Member

Tests of the Upper Sand, the first reservoir, were productive in 7/11-1X only, shaling out of the sands being the reason for unproductive tests in 7/11-2X and 3X. There is some evidence in 7/11-1X of pressure depletion of the Upper Sand (DST 5) during a test of the Middle Sand (DST 4) indicating accumulation continuity between the two sands (see Well Completion Report 7/11-1X, Appendix 3). A difference in gravities of oil recovered, a 48 psi datum pressure difference, and the intervention of the comparatively thick Shale Member between the two sand members, however, favor separate reservoirs to be the case. Continuity, if it exists, must be by way of the major north-south fault across the structure or other unmapped faults.

Middle Sand Member

Tests of the Middle Sand in the three wells indicate at least three definitely, and five possibly, separate reservoirs. The applicable bases for distinguishing one reservoir from the other above and below are indicated by arrows and are as follow:

(1) Unit VII: ↓ oil gravity, datum pressure, stratigraphic wedgeout.

(2) Units VI, V: ↑ oil gravity, datum pressure, stratigraphic wedgeout; ↓ chlorides.

(3) Units IV(?), III: ↑ chlorides; ↓ datum pressure

(4) Unit Ib: ↑ datum pressure; ↓ chlorides

(5) Unit Ia: ↑ chlorides, stratigraphic wedgeout

Details of each follow:

DST 7 of 7/11-3X indicates that Unit VII of the Middle Sand Member is distinct from section below as indicated by 47° API oil considerably different in color and lower in gravity than the 51°-52° condensate of DST 2 in 7/11-2X and the 50° condensate of DST 4 in 7/11-1X, and by a 70 psi datum pressure difference compared to DST 4 of 7/11-1X (Appendix 4). The wedgeout of Unit VII from 7/11-3X to 7/11-1X also indicates separation.

The separation of Units VI, V from IV(?), III is indicated by difference in parts per million of chlorides of water recovered in DST 6 and DST 5 in 7/11-3X.

The separation of Units VI, V, IV, III from Unit Ib is indicated by datum pressure difference between DST 4 and DST 3 in 7/11-1X. Further, separation of Units IV, III from Ib can be made on the basis of chlorides in DST 5 and DST 4 in 7/11-3X, and on the basis of datum pressure difference in DST 4 and DST 3 of 7/11-1X.

The separation of Unit Ib from Ia can be made on the basis of chlorides in DST 4 and 3 in 7/11-3X and on stratigraphic wedgeout.

The evidence for separation on the basis of chlorides is the weakest inasmuch as the volumes of water recoveries were relatively small, but some corroborating evidence was derived through log analysis which indicates change in water salinities from well to well (Appendix 5).

Lower Sand Members B and A

Tests of the Lower Sand Members gave no definite pressure information. Salt water in small amounts was recovered in both 7/11-2X (DST 1, covering Member B and A) and in 7/11-3X (DST's 1 and 2 covering Member B). The two members, however, are apt to consist of several separate reservoirs wherever porosity may be found in subsequent wells, judging by the thick shale units interbedded with the sands.

Danian

The Danian was not tested in 7/11-3X but accumulations in the Danian also, if subsequently found, will be separate from the overlying Lower Sand Member by virtue of the considerable number of impervious limestone and chalk beds intercalated with sands and shales. Tight section was tested in the Danian of 7/11-1X in DST's 1 and 2.

Gas-water Contacts

In the foregoing, the probability of multiple reservoirs indicates the possibility of different levels of gas-water contacts in each reservoir. For the time being the gas-water contact in the east side of the structure is taken at -10036 feet S.L. on the results of DST 7 in 7/11-3X and on the west side at -10103 feet S.L. on the basis of increased water saturations in zones below productive DST 2 as calculated in log analysis of 7/11-2X. Accordingly, the resulting area of closure containing hydrocarbons in the Cod structure is eight square miles.

CONCLUSIONS

The main conclusions derived from the results and data of the three wells drilled on the Cod structure relating to objectives and production possibilities involve subdivision of stratigraphic units, location of sand sources, location in the Tertiary and Paleocene basins, and distinction of reservoirs and limits of the Cod Field.

The Paleocene section is divided into two formations, the Upper Paleocene Cod formation and the Lower Paleocene Danian unnamed formation. Five members of the producing Cod formation are recognized: the Upper Sand, Shale, Middle Sand, Lower Sand B and Lower Sand A Members. The principal productive sand is the Middle Sand Member; possible future productive members are the two Lower Sand Members, and the Danian formation wherever porosity developments occur. The sands are turbidite deposits.

Reliable prediction of the direction of source and the best sand developments of the Cod formation elsewhere cannot be made yet.

It appears, however, that thicker section with good seismic reflection character is characteristic of sandy facies as opposed to thinner section with poor or no reflections is characteristic of shale facies. The initial choice of source of sands is south of Cod Field, from the structural high situated in U.K. waters in the area of Phillips Block 30/29, and 38/4,5. In any case, a southward source is postulated.

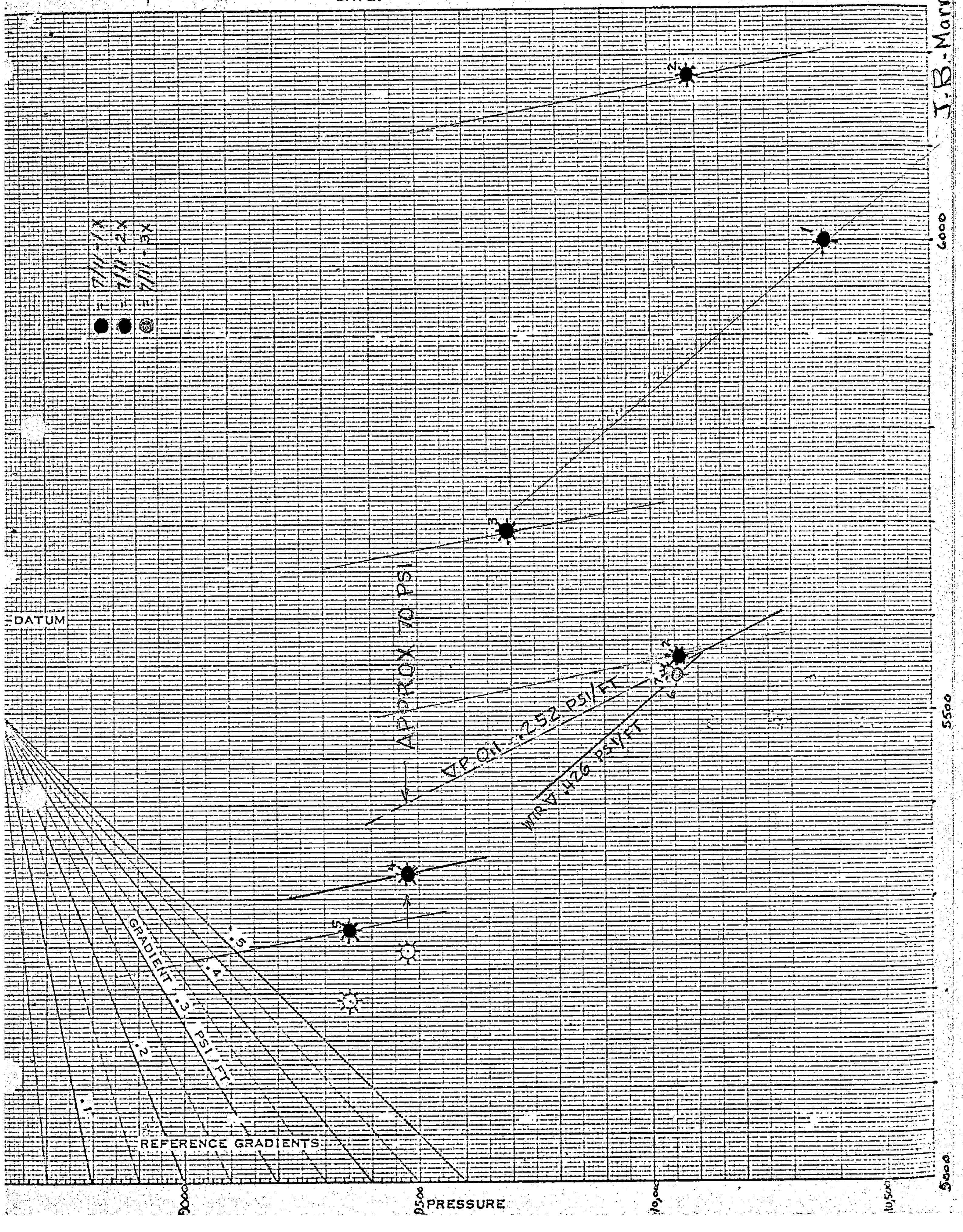
There is an apparent but unproved relationship in the coincident location of Paleocene turbidite sand deposits and present-day axis of Tertiary structural depression. A proved relationship and determination of maximum depression for the Paleocene as well as for other Tertiary Stages would allow prediction of other potentially productive sands. The best approach at present is by use of seismic record sections to relate reflection character with drilled sand sections in wells.

Six separate reservoirs within the Cod formation are indicated by the test pressures and recoveries and by stratigraphic evidence. Gas-water contacts on either side of the Cod structure, as suggested by the test results of 7/11-3X and log analysis of 7/11-2X, limit the hydrocarbon-bearing closure to eight square miles. Evidence to establish or disprove an oil ring or rings in the Field was not found.

APPENDIX 4

PRESSURE – DATUM GRAPH

DATE:



PHILLIPS PETROLEUM COMPANY
BARTLESVILLE, OKLAHOMA 74003

January 3, 1969

Re: E-NORWAY/PROD/RESERVOIR
Log Analysis 7/11-3X

Ref. No. BON-1-69

Mr. H. H. Heikkila
Oslo Office

Enclosed is a new log analysis for the 7/11-3X well based on the formation water resistivity as established by DST 6. While the previous analysis indicated these sands to be wet, this analysis makes this conclusion even more positive. The very top of the main Paleocene sand (10,131-36 and 10,139-41) shows some evidence of hydrocarbons. This may be a transition zone.

The salinity of the water recovered on DST 6 and 7 is substantially lower than was expected. The water salinities calculated from the S.P. logs on the three wells drilled to date are as follows:

7/11-1X

S.P. = -10 mv. Rmf = .069 @ 235°

Rw = .055 @ 235° or ≈ 40,000 ppm NaCl

7/11-2X

S.P. = +20 mv. Rmf = .019 @ 235°

Rw = .026 @ 235° or ≈100,000 ppm NaCl

7/11-3X

S.P. = +50 mv. Rmf = .0175 @ 235°

Rw = .04 @ 235° or ≈ 60,000 ppm NaCl

Thus, from the S.P. logs, I would have expected at least 40,000 ppm NaCl on the formation water and perhaps more. However, we know that the S.P. is not very reliable for the accurate determination of formation water, especially in the higher concentrations. It is not clear whether these three wells have the same formation water. Again, the S.P. logs cannot be taken as completely reliable, but they certainly suggest a changing Rw from well to well.

One final point should be kept in mind: If the formation water in the Paleocene sand in the first two wells is as fresh as the water recovered from the 3X well, the water saturations are substantially higher than we previously calculated and the reserves should be reduced accordingly. Perhaps additional drilling and testing will clarify this point.

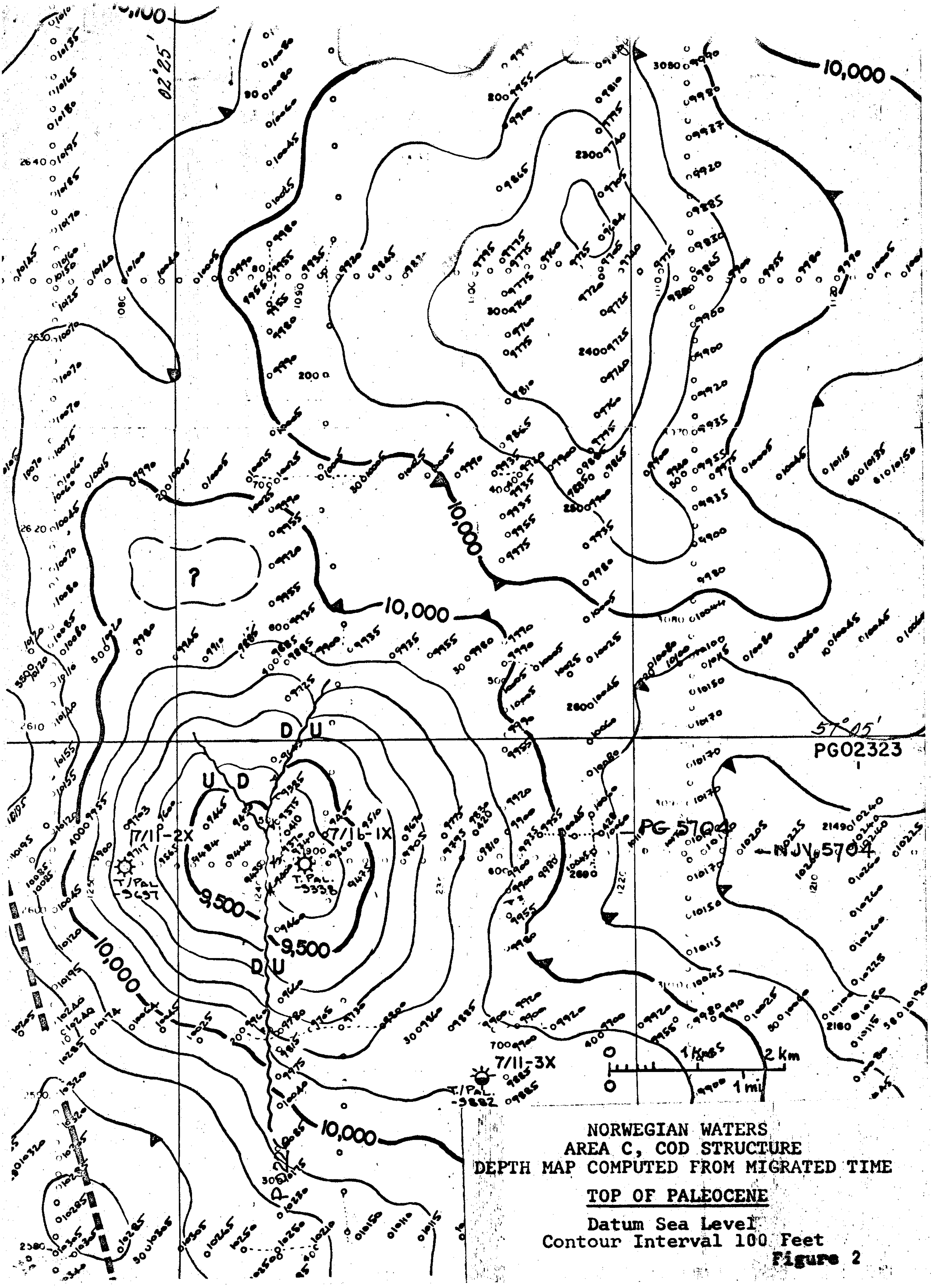
If there are any questions or comments, please advise.

Joe Owen

Joe D. Owen

JDO:erm
Attach. Log Analysis 7/11-3X

cc: Messrs. Owen D. Thomas (r) LMR, DDW
W. W. Dunn (r) Silvio Eha w/Attach.
Ralph L. Young

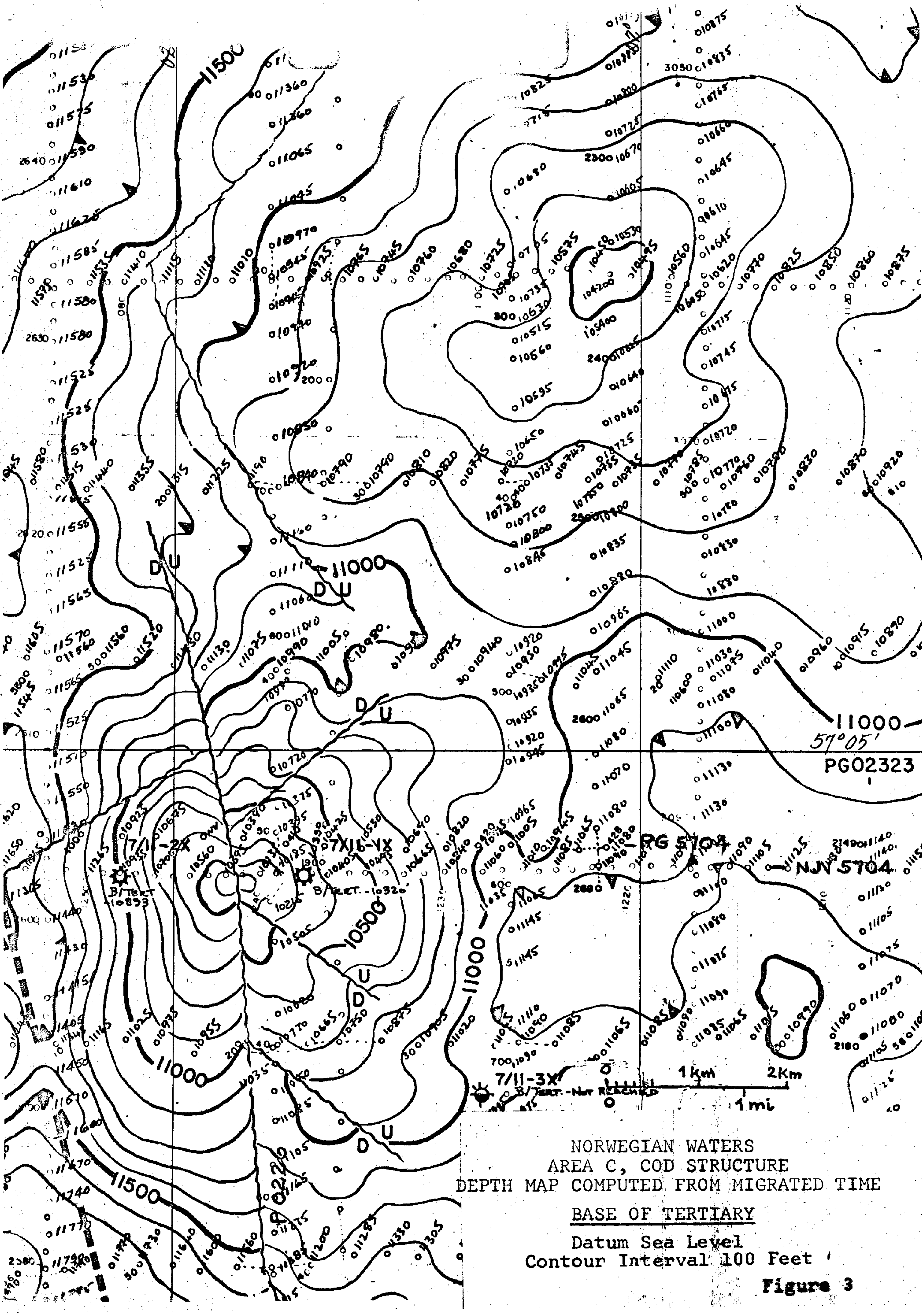


NORWEGIAN WATERS
AREA C, COD STRUCTURE
DEPTH MAP COMPUTED FROM MIGRATED TIME

TOP OF PALEOCENE

Datum Sea Level
Contour Interval 100 Feet

Figure 2



NORWEGIAN WATERS
AREA C, COD STRUCTURE
DEPTH MAP COMPUTED FROM MIGRATED TIME

BASE OF TERTIARY

Datum Sea Level
Contour Interval 100 Feet

Figure 3

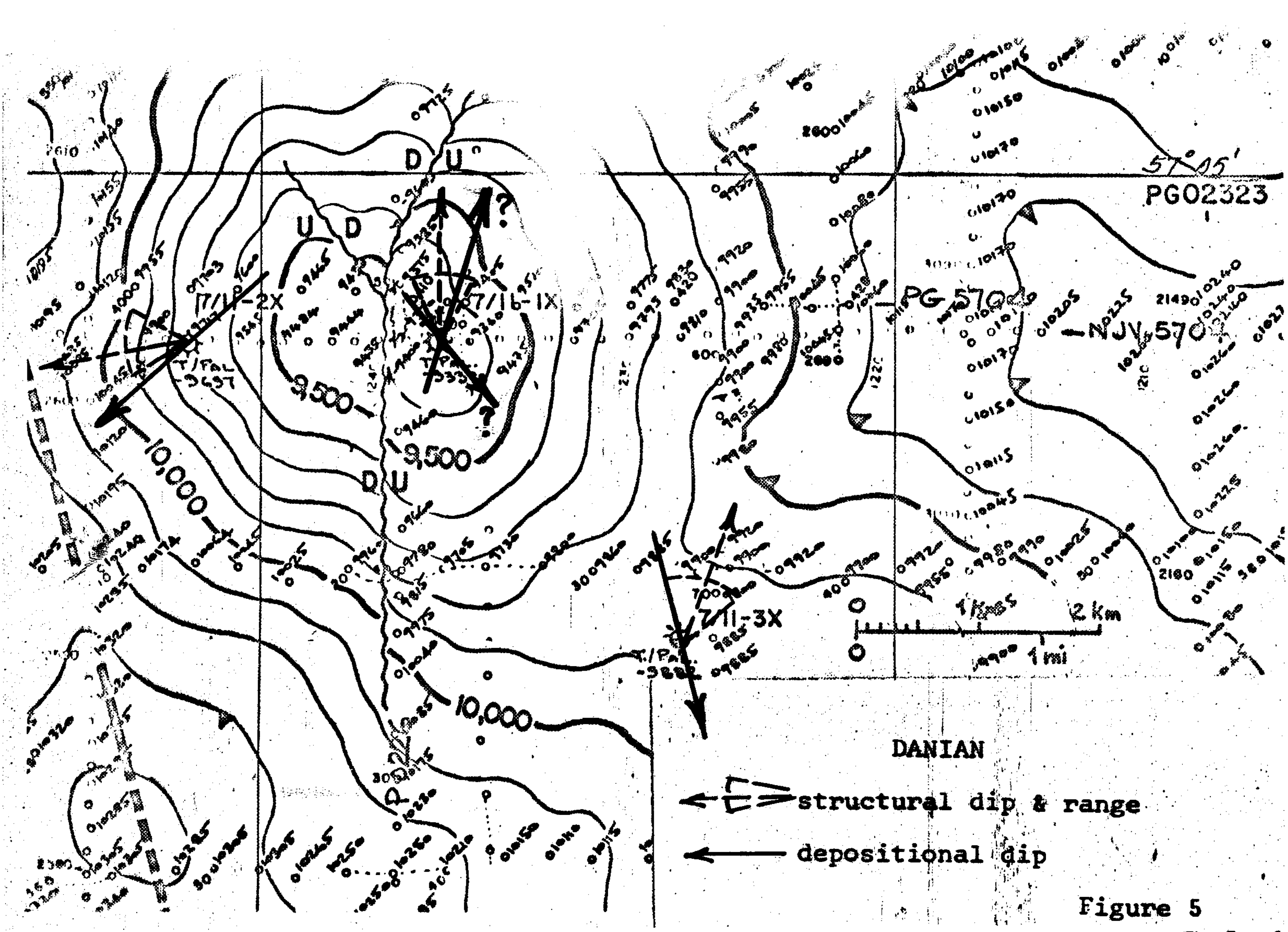
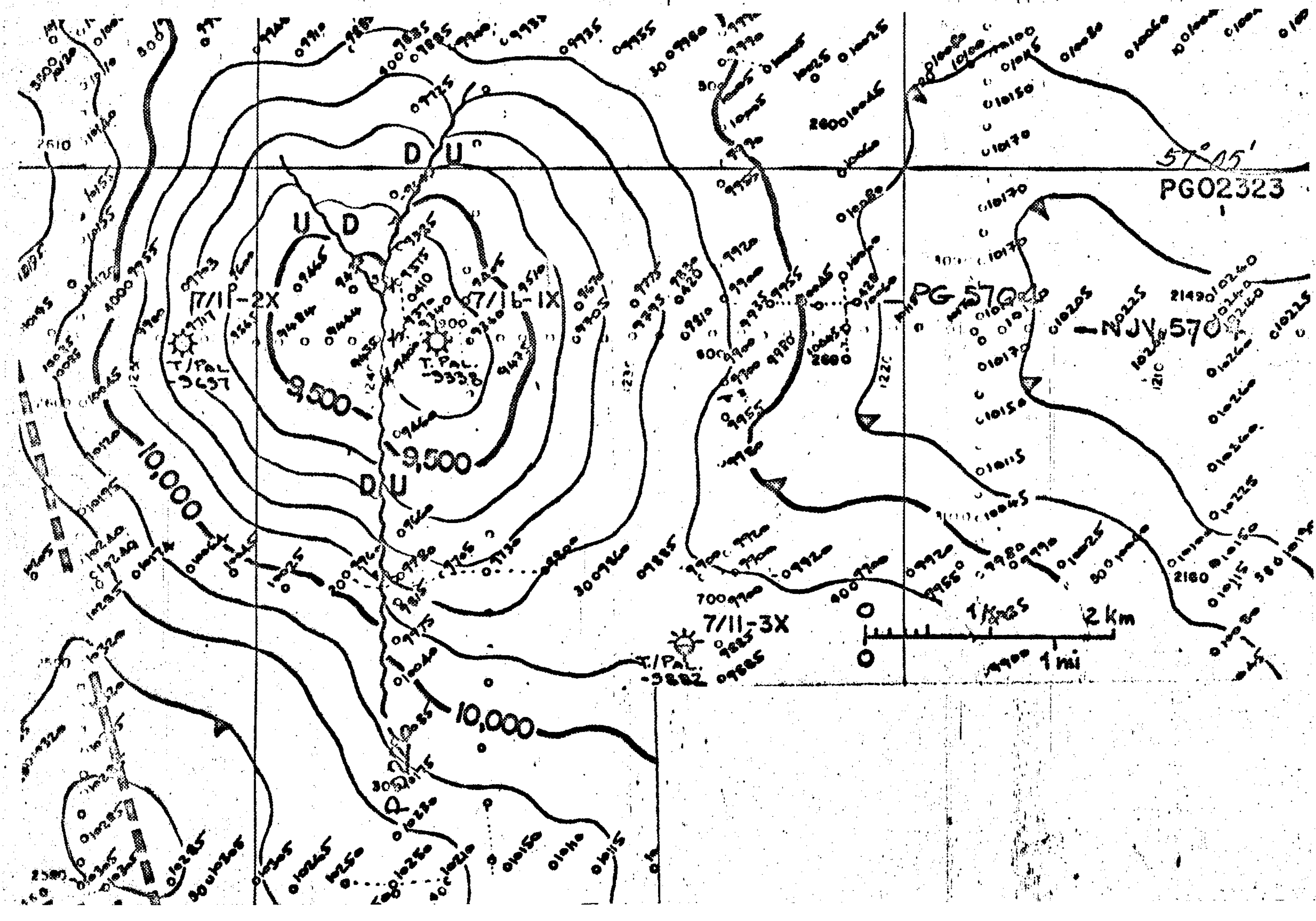

57°05'
PG02323
7/11-2X
7/16-1X
T/PAL.
-3637
-3338
9,500
10,000
7/11-3X
T/PAL.
-3882
2 Km
1 mi
DANIAN
structural dip & range
depositional dip

Figure 5


57°05'
PG02323
7/11-2X
7/16-1X
T/PAL.
-3637
-3338
9,500
10,000
7/11-3X
T/PAL.
-3882
2 Km
1 mi

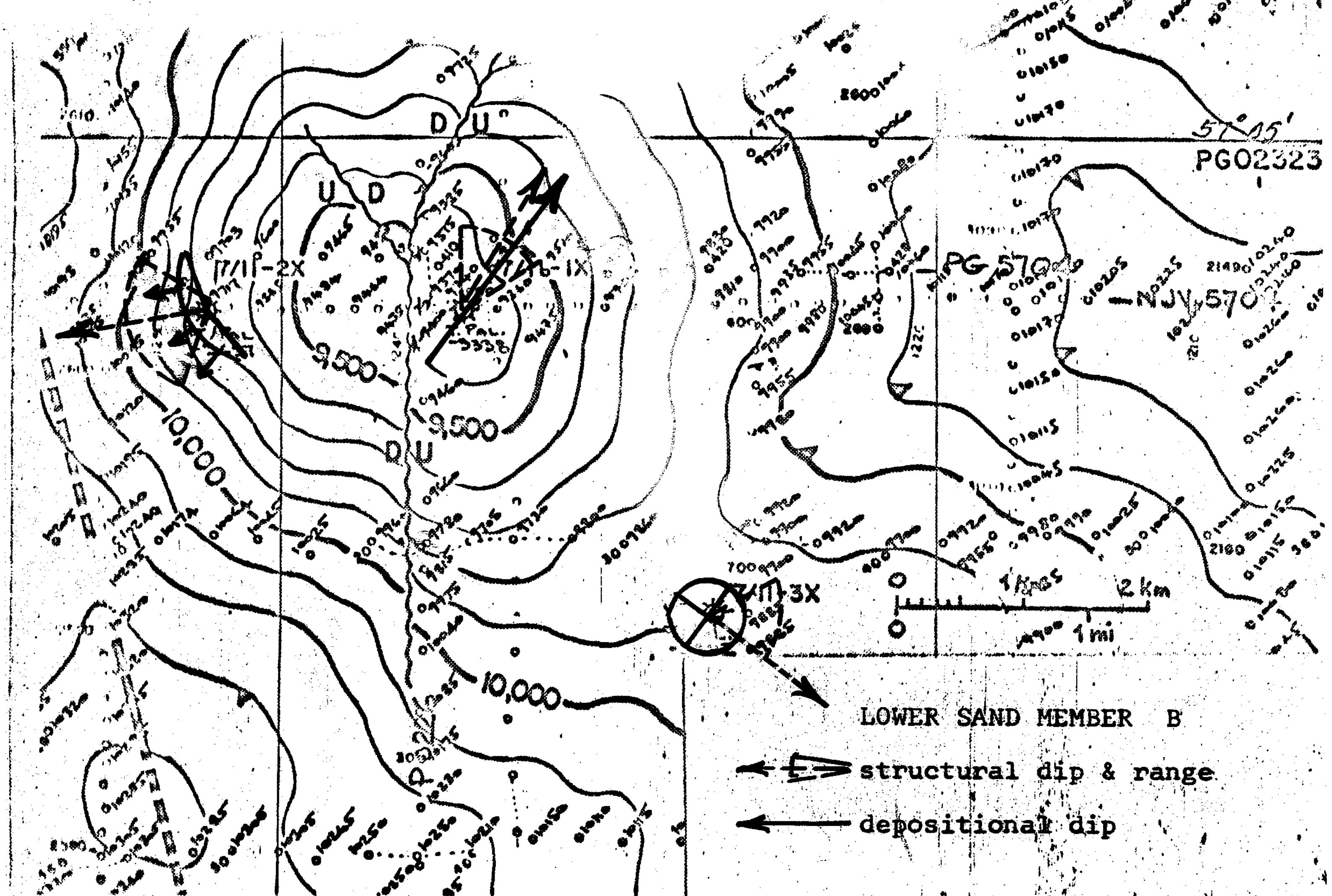


Figure 6 B

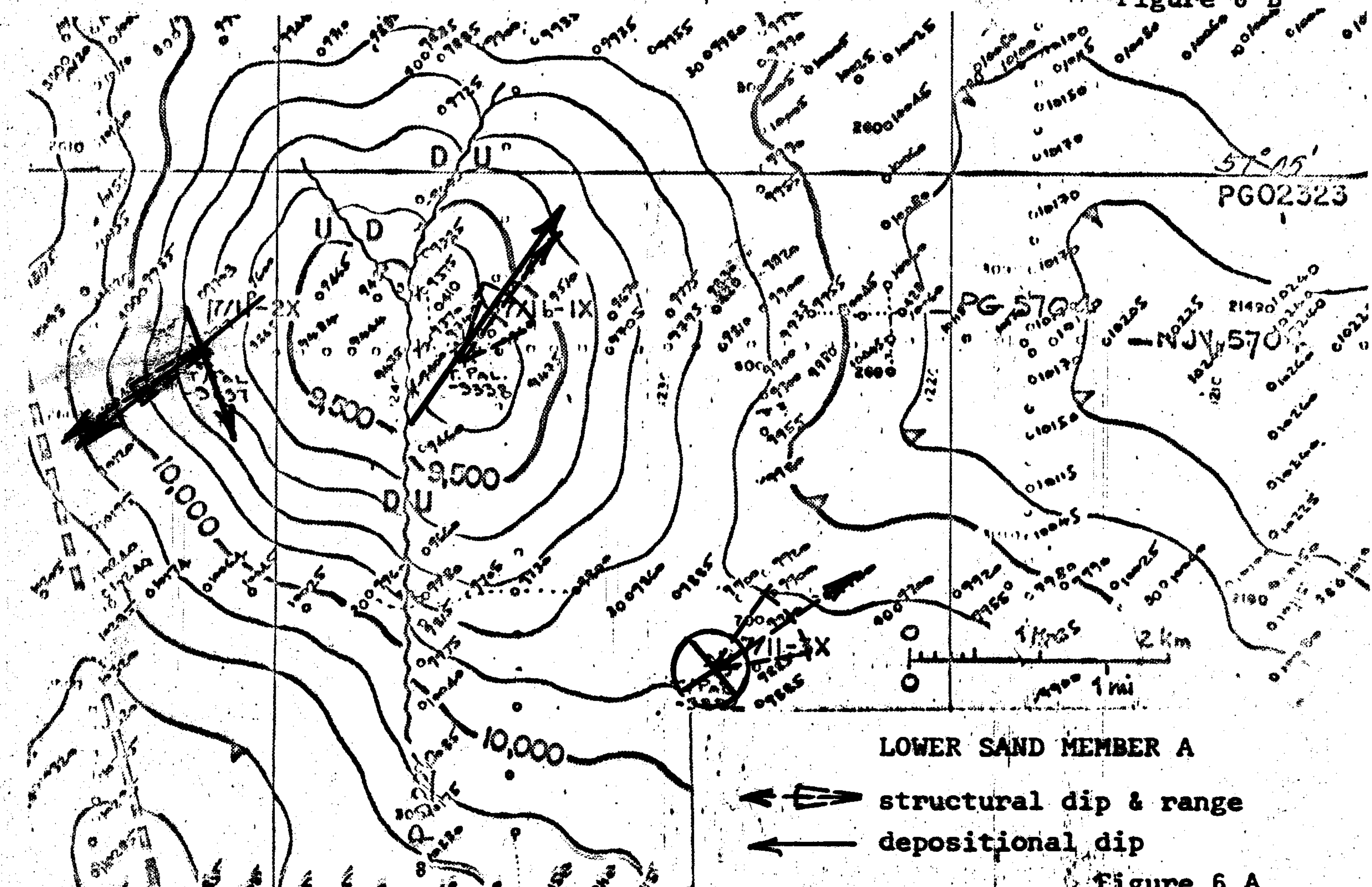


Figure 6 A

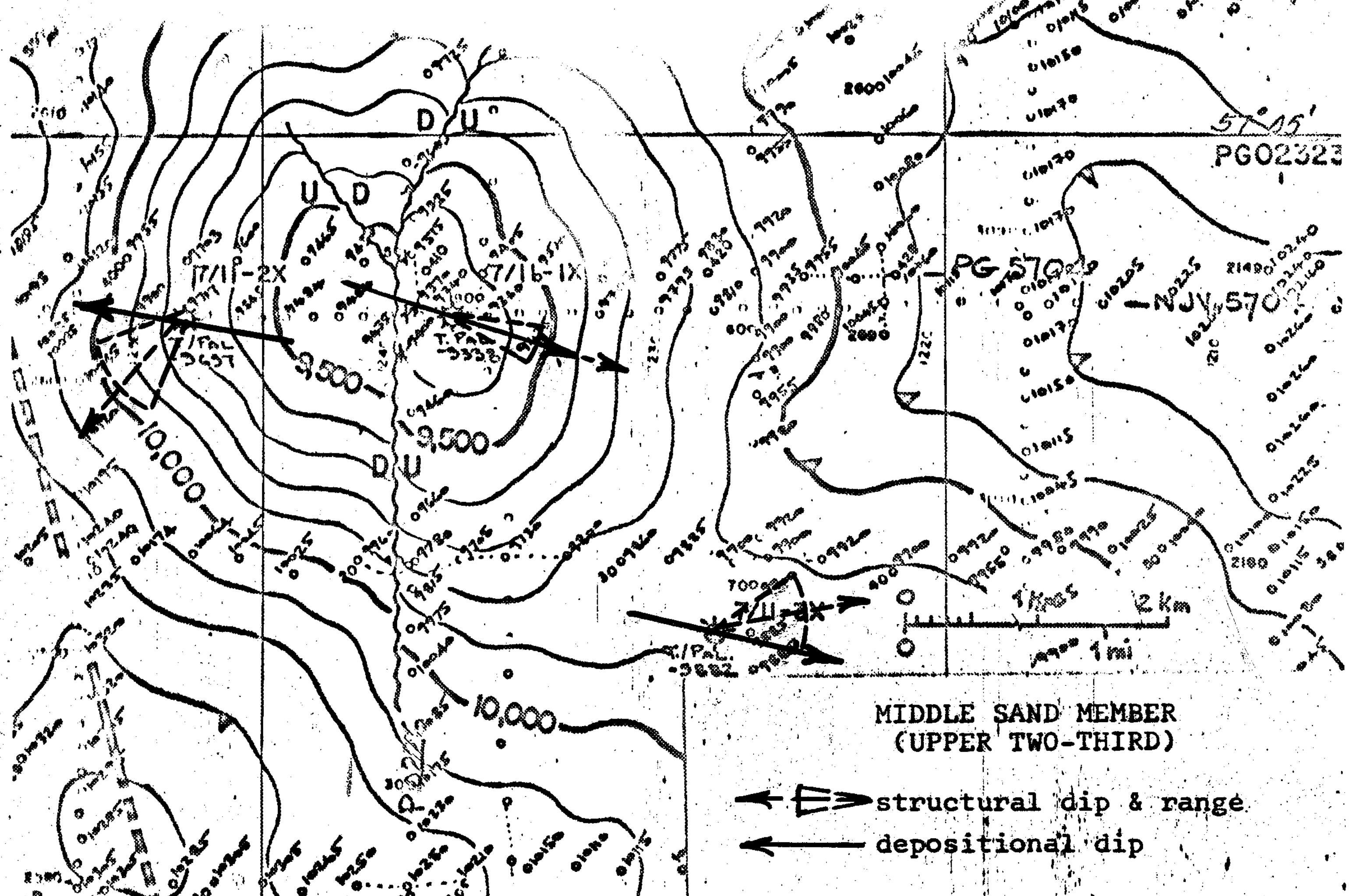


Figure 7 B

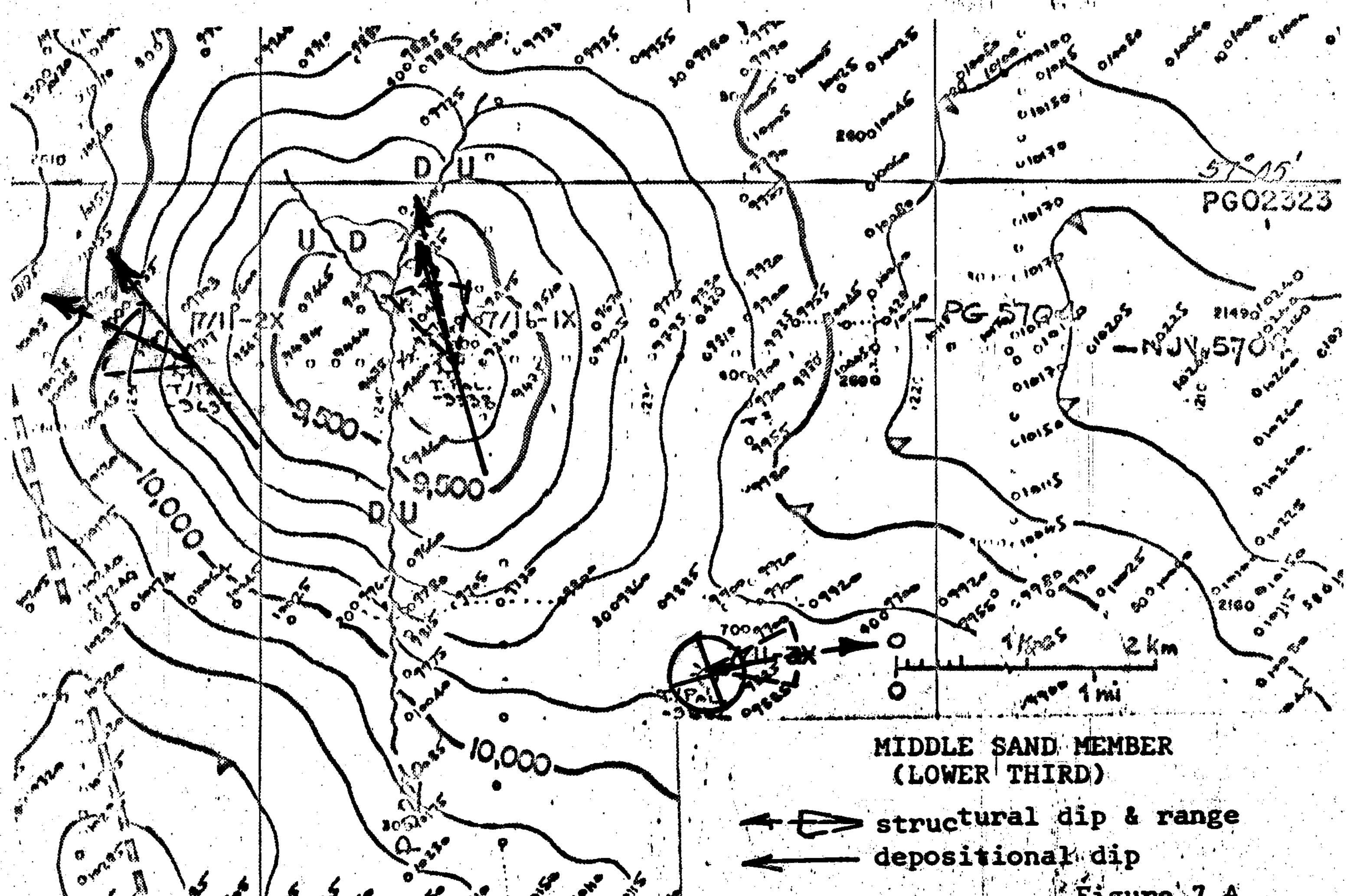


Figure 7 A

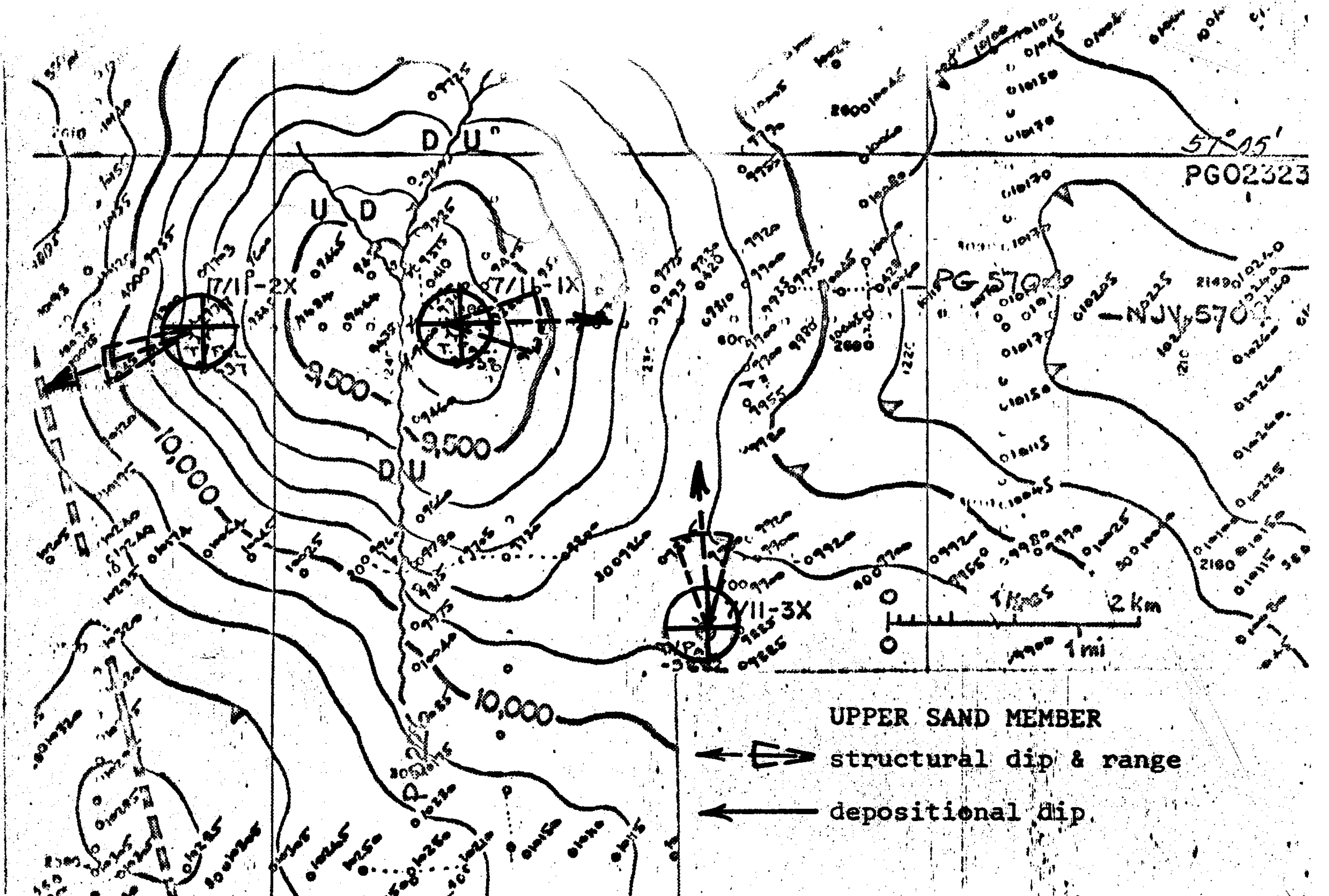


Figure 8 B

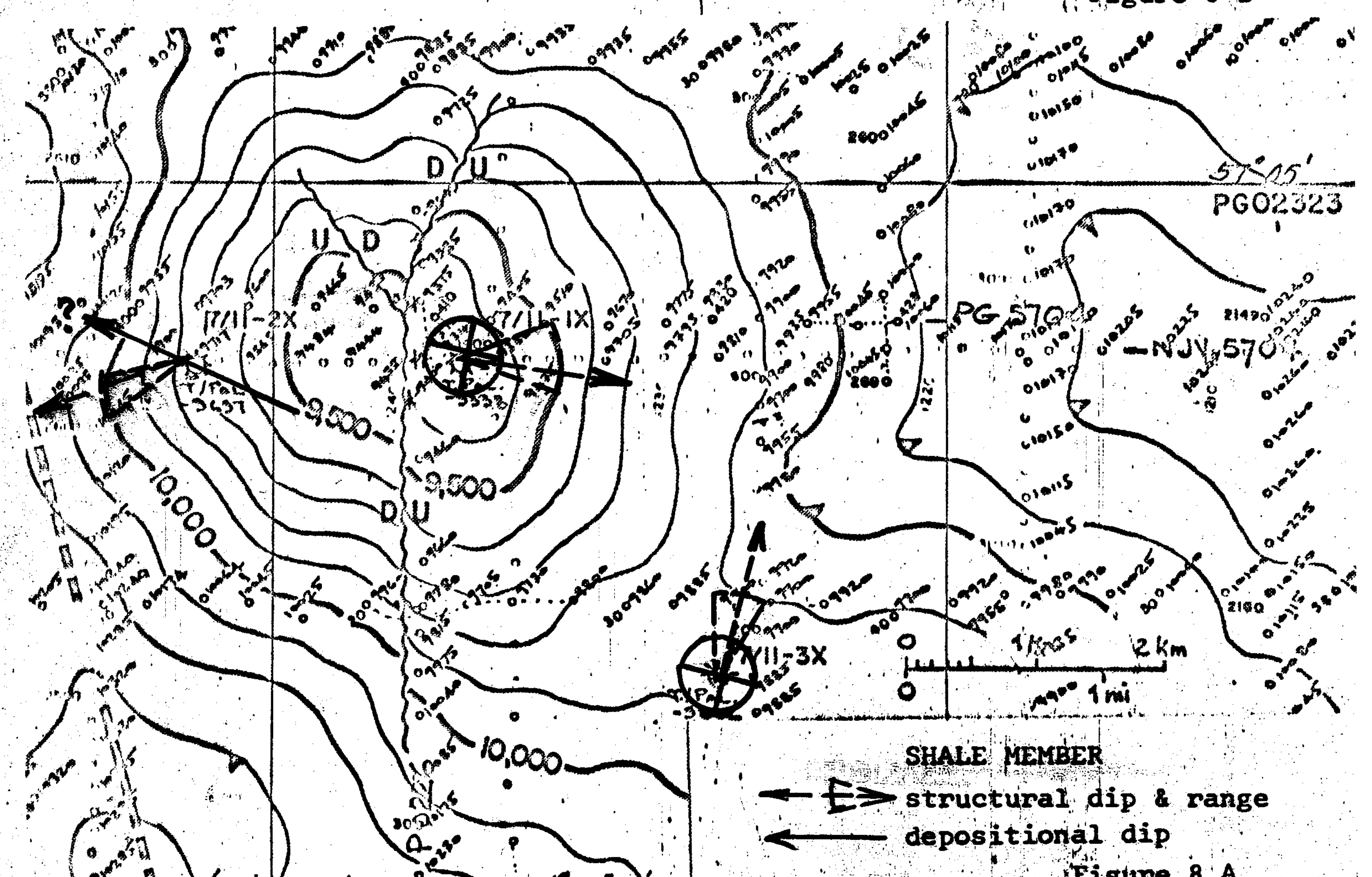


Figure 8 A

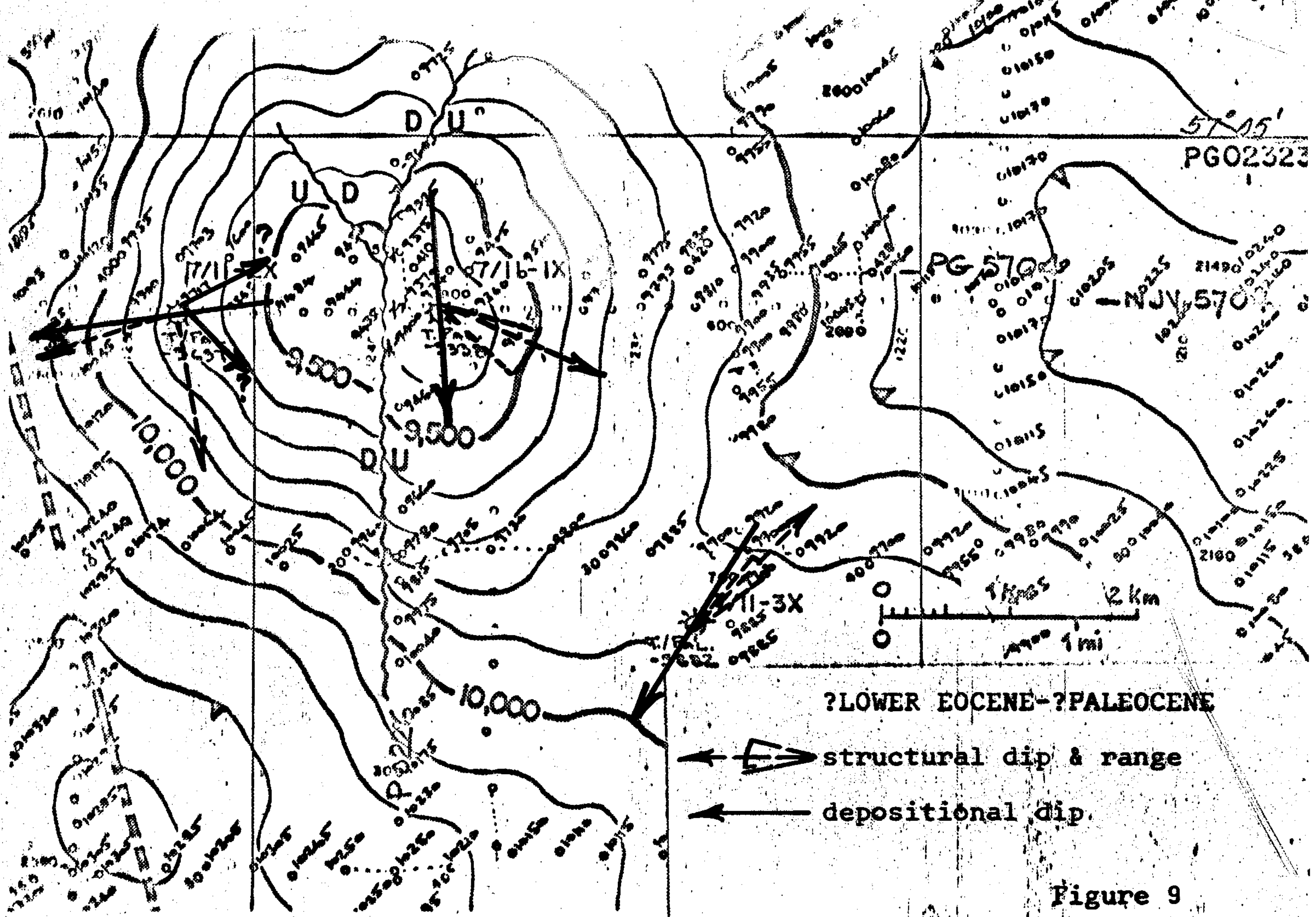
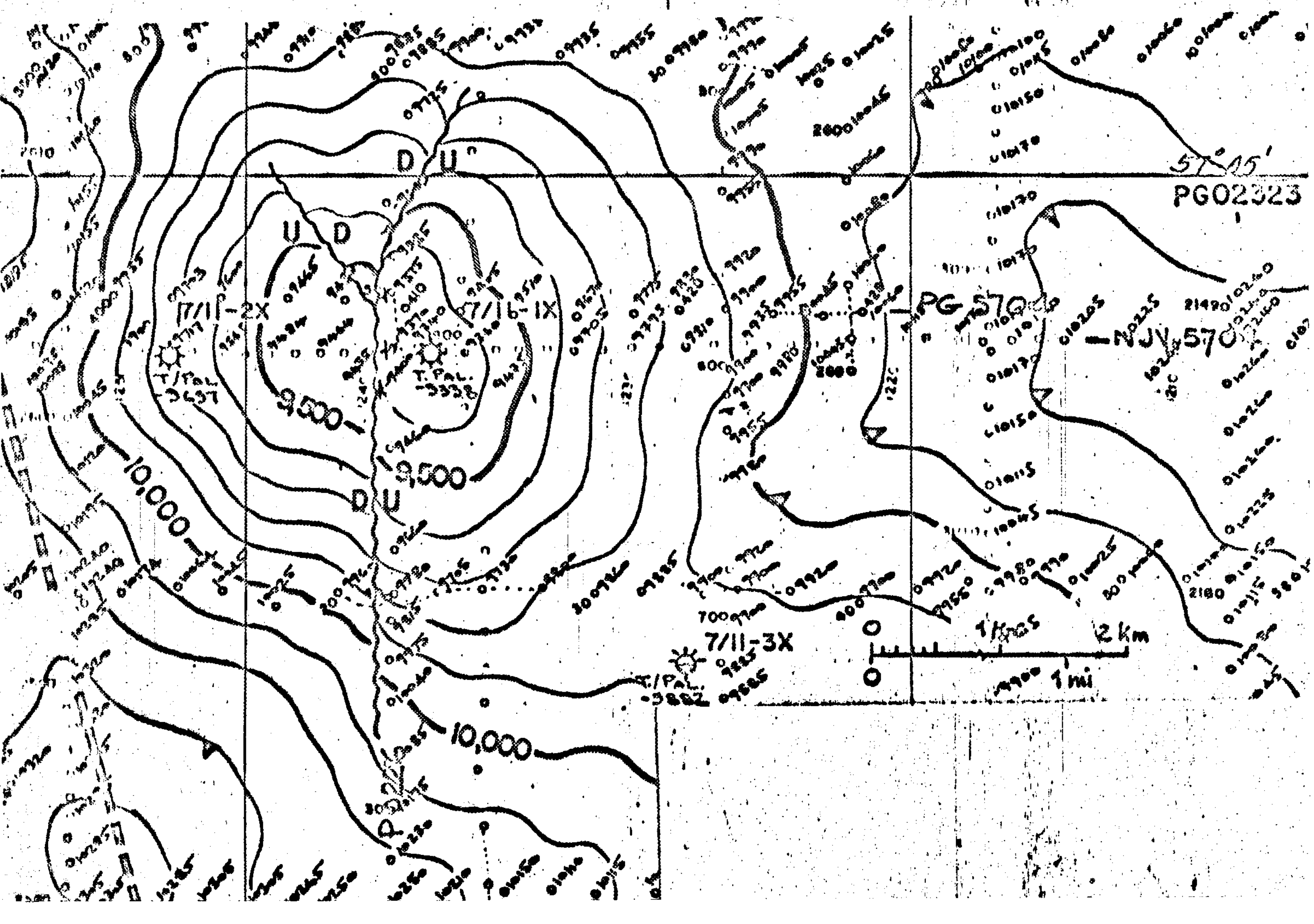

?LOWER EOCENE-?PALEOCENE
structural dip & range
depositional dip
PG02323
PG 570
NJV 570
7/11-2X
7/16-1X
7/11-3X
9,500
10,000
2 km
1 mi

Figure 9


PG02323
PG 570
NJV 570
7/11-2X
7/16-1X
7/11-3X
9,500
10,000
2 km
1 mi

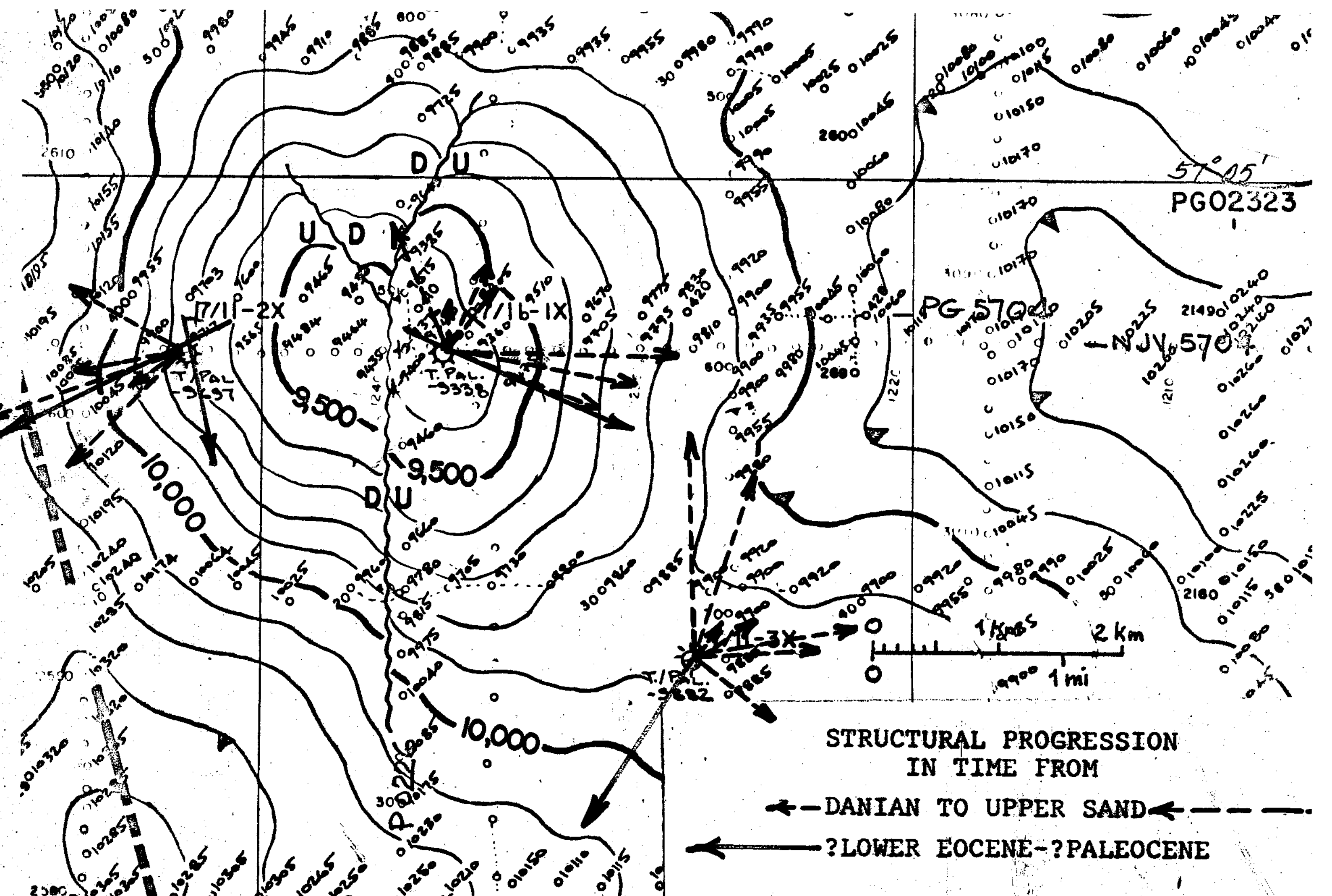


Figure 10 B

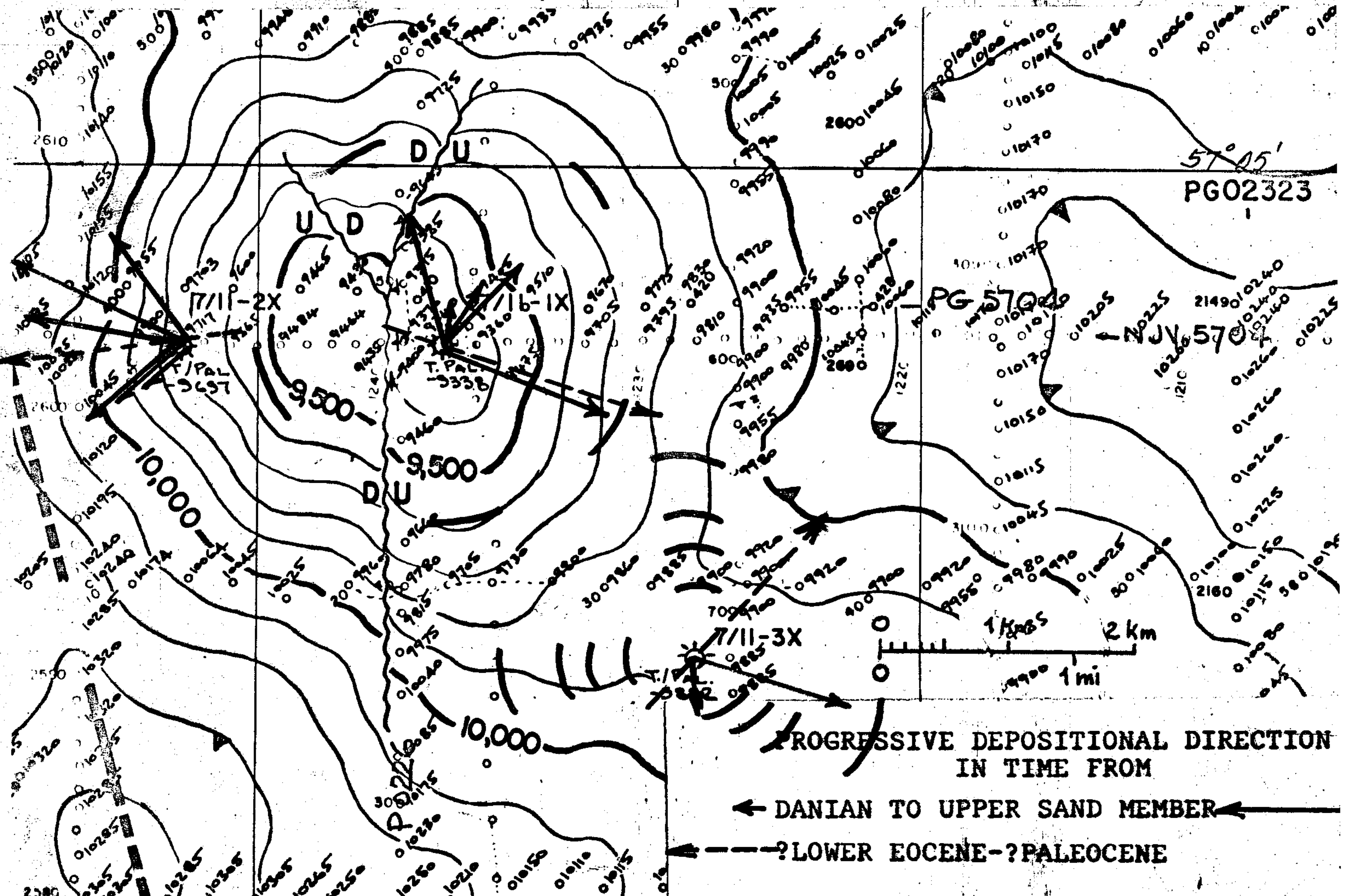


Figure 10 A