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#6

June 19, 1980

TO: Husky/U. S. Geological Survey

RE: Husky/USGS, NPR-A
Lisburne #1
Sec. 17, 11S/16W, U.B.M.
North Slope, Alaska

FORAMINIFERA REPORT

The following micropaleontological report is based on the examination and checklisting of 368 washed ditch samples, 305 thin sectioned ditch samples, 69 washed conventional core samples and 112 thin sectioned conventional core samples covering the interval 130 to 17,000 feet. Seven (7) checklists and two faunal distribution logs are enclosed for your convenience. The lithologic descriptions and correlations of the five plates encountered are summarized in Appendix A at the back of this report. Appendix B contains the results of the examination of three outcrop samples from the vicinity of the Lisburne #1 well.

Standard techniques were employed in processing the material. All washed samples were boiled in Quaternary-O and washed over 20 and 200 mesh screens. Thin sections were prepared on all carbonates. Ditch sample chips were first embedded in resin cubes prior to sectioning.

Frequency symbols used in this report correspond to the following numerical values: R = rare (1-5); F = frequent (6-32); C = common (33-99); A = abundant (100-199); and FL = flood (200+).

RE: Husky/USGS - Lisburne #1, North Slope, Alaska

In general, the facies encountered in this well are much different from their time-equivalent counterparts found in the subsurface to the north. This is especially true for rocks of Permian to Aptian age, most of which appear to represent a radiolarian-rich, open marine (possibly below compensation depth) facies in this well. Foraminifera are rare throughout the clastic section above the Lisburne Group carbonates, and dominated by agglutinated forms. Calcareous forms are sparse and scattered.

Besides having to deal with the problems of working with facies where the Foraminifera are poorly developed, this well also has structural complications in the form of five repeated stratigraphic intervals. An interval-by-interval summary of the Lisburne #1 well is presented below. For convenience, each repeated stratigraphic interval is referred to as a plate (i.e. Plate 1, Plate 2, etc.) inferring that they are the product of thrust faulting. The reader is cautioned, however, that while the micropaleontological data can document the repeat, other data needs to be consulted to establish the exact mechanism responsible for the repeat.

A plate-by-plate interval summary of the Lisburne #1 well is presented below.

RE: Husky/USGS - Lisburne #1, North Slope, Alaska

PLATE 1

130-2220'

This interval contains a poor fauna characterized by Cenosphaera spp., Spongodiscus spp., Dictyomitra spp., Gaudryina cf. tailleuri, and arenaceous spp. A few single specimen occurrences of typically Neocomian forms were found in this interval, but these are believed to be reworked at this time. A probable Aptian (F-11) age is suggested for these strata based on the radiolarian dominated assemblage described above, and the palynological data.

These rocks probably represent open marine, possibly below compensation depth, deposition.

AGE: Early Cretaceous
(Probable Aptian)
F-11

ENVIRONMENT: Open Marine (Possible Bathyal)

2220-6100'

These strata are considered to be Neocomian (Hauterivian to Barremian) based on more consistent occurrences of such forms as; Bathysiphon scintillata, Trochammina cf. squamata, Haplophragmoides duoflatis, H. goodenoughensis, Thuramminoides septagonalis, Reophax tundraensis, Glomospira subarctica, Glomospirella arctica, Ammodiscus mackenziensis, Gaudryina cf. tappanae, G. tailleuri and Lituotuba gallupi.

RE: Husky/USGS - Lisburne #1, North Slope, Alaska

2220-6100' (con't.)

An open marine (possibly below compensation depth) depositional environment is suggested for these rocks also.

AGE: Early Cretaceous
(Hauterivian to Barremian)
F-12 to F-13

ENVIRONMENT: Open Marine (Basinal?)

6100-6940'

The siliceous shales found throughout this interval are characterized by frequent to common radiolaria. Foraminifera are sparse and predominantly agglutinated. The few forms found suggest a Jurassic (possibly Early to Middle Jurassic below 6760 feet) to Early Cretaceous (Neocomian) age. The consistent occurrence of radiolaria is indicative of open marine conditions. The lack of calcareous Foraminifera suggests the possibility of deposition below compensation depth.

AGE: Jurassic to Early Cretaceous
(Neocomian)
(Undifferentiated)

ENVIRONMENT: Open Marine (Basinal?)

6940-7210'

This unit is picked on the basis of a lithologic change to dark brown to black argillaceous limestone and chert. Once again these rocks contain frequent to common radiolaria. Rare occurrences of Ammodiscus cf. P and Citharina entypomatus coupled with the above described lithology is the only

RE: Husky/USGS - Lisburne #1, North Slope, Alaska

6940-7210' (con't.)

evidence we have for a Triassic (F-19) age, but additional fauna found in this interval on subsequent plates supports this age.

AGE: Triassic (F-19)

ENVIRONMENT: Open Marine (Outer Shelf to Foreslope)

7210-7390'

This unit is differentiated on the basis of a lithologic change to black shale followed by another lithologic change to dark brown siliceous shale and chert. The presence of Ammodiscus P in this interval suggests a Permo-Triassic (F-20) age for these rocks, but Protonodosaria sp. and Paleoaplysina sp. found from the lower part of this interval on Plate 5 indicates that the age could be as old as Early Permian (A.W.A. F-21). Frequent to common radiolaria suggest open marine basinal conditions.

AGE: Permo-Triassic (Probable F-20 to F-21)

ENVIRONMENT: Open Marine (Basinal?)

7390-8220'

Occurrences of Pseudoglomospira sp., Trepeilopsis sp., Earlandia clavatula, E. elegans, Endothyra spp., Calcisphaera pachysphaerica, Girvanella ducii and Stacheoides meandriformis characterize these heavily recrystallized packstones and

RE: Husky/USGS - Lisburne #1, North Slope, Alaska

7390-8220' (con't.)

wackestones. Based on negative evidence coupled with a comparison of the fauna recovered from this interval on all 5 plates a Late Mississippian (probable Zone 14 to Zone 16) age is tentatively placed on this interval. The recrystallization of these rocks makes an environmental interpretation difficult, but these packstones and wackestones probably represent shallow carbonate shelf (open platform to bank) deposition.

AGE: Late Mississippian
(Probable Zone 14 to Zone 16)

ENVIRONMENT: Shelf (Open Platform to Bank)

8220-8610'

The recrystallization is much less in this interval allowing for a better age determination. Based on occurrences of Globoendothyra tomilensis group, G. baileyi group, Endothyra bowmani group, Endothyranopsis compressa, Earlandia vulgaris, Earlandinella sp. (pl. 26), Glomospiranella sp. (pl. 28), Shartymophycus sp. and Koninckopora inflata these rocks are Late Mississippian (Zone 12 to Zone 13) in age.

Depositional environments appear to be as follows: restricted platform (lagoonal) between 8220 feet and 8400 feet, open platform to bank between 8400 feet and 8610 feet.

AGE: Late Mississippian
(Zone 12 to Zone 13)

ENVIRONMENT: Shelf
8220-8400 Restricted Platform (lagoonal)
8400-8610 Open Platform to Bank

RE: Husky/USGS - Lisburne #1, North Slope, Alaska

REPEAT OF SECTION

PLATE 2

8610-9030'

This interval, like on the previous plate, contains rare to frequent radiolaria and sparse nondiagnostic Foraminifera. Based on its stratigraphic position it could be as old as Jurassic or as young as Early Cretaceous (Neocomian). The presence of radiolaria indicates open marine conditions; the lack of calcareous Foraminifera suggests deposition below compensation depth.

AGE: Jurassic to Early Cretaceous (Neocomian) (Undifferentiated)

ENVIRONMENT: Open Marine (Basinal?)

9030-9420'

The presence of Astacolus connudatus, Ammobaculites cf. vetusta and questionable Nodosaria larina coupled with a lithologic change to dark brown to black argillaceous limestone and chert indicates that these strata are Triassic (F-19) in age. The depositional environment was probably open marine (outer shelf to foreslope).

AGE: Triassic (F-19)

ENVIRONMENT: Open Marine (Outer Shelf to Foreslope)

RE: Husky/USGS - Lisburne #1, North Slope, Alaska

9420-9650'

This unit is characterized by rare to common radiolaria. There were no age diagnostic Foraminifera found. The black shale occurring between 9420 feet and 9570 feet is lithologically similar to the interval 7210 to 7300 feet on Plate 1. The dark brown and light greenish-gray siliceous shale and chert found below 9570 feet (9570-9650 feet), is lithologically similar to the interval 7300 to 7390 feet on Plate 1.

AGE: Permo-Triassic
(Probable F-20 to F-21)

ENVIRONMENT: Open Marine (Basinal?)

9650-10,570'

Occurrences of Pseudoglomospira sp., Trepeilopsis sp., Earlandia elegans, Archaediscus krestovnikovi, questionable Globoendothyra tomiliensis group, questionable Endothyra similis group and questionable Eoendothyranopsis sp. characterize these recrystallized packstones and wackestones. A Late Mississippian (probable Zone 14 to Zone 16) age is suggested for these strata. This interval is very similar to the interval 7390 to 8220 feet on Plate 1.

AGE: Late Mississippian
(Probable Zone 14 to Zone 16)

ENVIRONMENT: Shelf (Open Platform to Bank between 9650 feet and 10,450 feet; Restricted Platform between 10,450 feet and 10,570 feet)

RE: Husky/USGS - Lisburne #1, North Slope, Alaska

10,570-10,900'

The bottom interval on Plate 2, like Plate 1, is much less recrystallized. Occurrences of Endothyra bowmani group, Eoendothyranopsis rara group, Earlandinella sp. (pl. 26), Globoendothyra tomiliensis group, G. baileyi group, Brunsia pulchra, B. lenensis, Skippella cf. redwallensis and Eoforschia moelleri indicate a Late Mississippian (Zone 12 to Zone 13) age for these open platform to bank carbonates.

AGE: Late Mississippian (Zone 12 to Zone 13)

ENVIRONMENT: Shelf (Open Platform to Bank)

RE: Husky/USGS - Lisburne #1, North Slope, Alaska

REPEAT OF SECTION

PLATE 3

10,900-11,050'

This interval, like on the previous plates, contains rare to frequent radiolaria and nodosariid Foraminifera. Based on its stratigraphic position it could be as old as Jurassic or as young as Early Cretaceous (Neocomian). The presence of radiolaria indicates open marine conditions. The occurrence of nodosariids suggests outer neritic to upper bathyal paleo-depths.

AGE: Jurassic to Early Cretaceous (Neocomian)' (Undifferentiated)

ENVIRONMENT: Open Marine (Outer Neritic to Upper Bathyal)

11,050-11,320'

This unit is picked on a lithologic basis. The change to dark brown to black argillaceous limestone and chert suggests that these strata correlate with strata that are Triassic (F-19) in age on the previous plates. The depositional environment was probably open marine (outer shelf to foreslope).

AGE: Triassic (F-19)

ENVIRONMENT: Open Marine (Outer Shelf to Foreslope)

RE: Husky/USGS - Lisburne #1, North Slope, Alaska

11,320-11,540'

This unit, like on the previous plate, is characterized by radiolaria. There were no diagnostic Foraminifera found. A black shale is found between 11,320 feet and 11,450 feet followed by a brown and greenish-gray siliceous shale and chert interval. Based on fauna recovered from this lithologic unit on other plates, it appears this unit represents Permo-Triassic (probable F-20 to F-21) deposition.

AGE: Permo-Triassic
(Probable F-20 to F-21)

ENVIRONMENT: Open Marine (Basinal?)

11,540-12,330'

This interval was essentially barren of identifiable Foraminifera, due to recrystallization, above 12,120 feet. Occurrences of Endothyra spp., E. bowmani group, Pseudoglomospira sp., Earlandia elegans, E. clavatula, Priscella sp., Girvanella ducii and frequent to common coral wall debris suggest a Late Mississippian (probable Zone 14 to Zone 16) age for these carbonates. An increase in the amount of dolomite on this plate compared to the overlying two plates suggests fluctuating supratidal to open platform and bank conditions. The reader is referred to appendix figure 3 for environmental details.

AGE: Late Mississippian
(Probable Zone 14 to Zone 16)

ENVIRONMENT: Shelf (Supratidal to Bank)

RE: Husky/USGS - Lisburne #1, North Slope, Alaska

12,330-13,050'

This unit is much less recrystallized. It contains occurrences of Paracaligelloides obicus, Endothyra spp., E. bowmani group, Pseudoglomospira sp., Earlandia elegans, E. clavatula, E. vulgaris, Globoendothyra tomiliensis, G. spp., Eoendothyranopsis spiroides group, E. ermakiensis, Earlandinella sp. (pl. 26), Eoforschia moelleri, Priscella prisca, Glomospiranella sp. (pl. 28), Latiendothyra parakosvensis, Stacheoides tenuis, Stacheia skimoensis and frequent to common coral wall debris.

Depositional environments appear to be as follows; restricted to open platform (lagoonal) between 12,330 feet and 12,630 feet, open platform to bank between 12,630 feet and 12,750 feet, and restricted to open platform between 12,750 feet and 13,050 feet.

AGE: Late Mississippian (Zone 12 to Zone 13)

ENVIRONMENT: Shelf (Restricted Platform to Bank)

13,050-13,370'

These wackestones, packstones and lime mudstones are characterized by a large reduction in fauna. Since Stacheia skimoensis was found frequently in Core 20, well down in this interval, on Plate 5 we feel that we are dealing with poorly fossiliferous rocks that are no older than Zone 12 in age.

AGE: Late Mississippian (Probable Zone 12 to Zone 13)

ENVIRONMENT: Shelf (Restricted to Open Platform)

RE: Husky/USGS - Lisburne #1, North Slope, Alaska

REPEAT OF SECTION

PLATE 4

13,370-13,730'

Rare to frequent radiolaria and a questionable conodont fragment occur in ditch samples from this interval. Core 6 (13,601-13,609') contains Ammodiscus P, Bathysiphon anomalocoelia and a questionable Endothyra sp. The above faunal occurrences in conjunction with fauna recovered from this interval on other plates suggest a probable Permo-Triassic (F-20 to F-21) age for these rocks.

AGE: Permo-Triassic
(Probable F-20 to F-21)

ENVIRONMENT: Open Marine (Outer Shelf? to Slope?)

13,730-14,480'

Occurrences of Globoendothyra sp., Endothyra spp., Trepeilopsis sp., Earlandia elegans, Brunsia lenensis, Girvanella ducii and rare coral wall debris in ditch and core samples characterize these heavily recrystallized packstones and wackestones. Negative evidence coupled with a comparison of the fauna recovered from this interval on all five plates suggests a Late Mississippian (probable Zone 14 to Zone 16) age. The high degree of recrystallization and silicification of these packstones and wackestones makes it difficult to make an environmental interpretation. These altered packstones, wackestones, and silicified limestones probably

RE: Husky/USGS - Lisburne #1, North Slope, Alaska

13,730-14,480' (con't.)

represent shallow carbonate shelf (open platform to bank) deposition. The dolomites found above 13,820 feet suggest some restricted platform or supratidal deposition.

AGE: Late Mississippian
(Probable Zone 14 to Zone 16)

ENVIRONMENT: Shelf (Supratidal to Bank)

14,480-15,150'

This less recrystallized interval contains Brunsia lenensis, Endothyra spp., E. bowmani group, Dainella anivikensis, Earlandia moderata, E. elegans, E. clavatula, Globoendothyra tomiliensis, Paracaligelloides obicus, Trepeilopsis sp., Girvanella ducii, Shartymophycus sp. and rare to common coral wall debris. The above association suggests a Late Mississippian (Zone 12 to Zone 13) age for these strata.

Depositional environments were probably predominantly open platform to bank with some restricted platform (lagoonal) deposition.

AGE: Late Mississippian
(Zone 12 to Zone 13)

ENVIRONMENT: Shelf (Restricted Platform to Bank)

15,150-15,320'

These packstones, wackestones, and spiculitic lime mudstones are faunally poor, and it is only due to the presence of Stacheia skimoensis in this interval on Plate 5 that we can

RE: Husky/USGS - Lisburne #1, North Slope, Alaska

15,150-15,320' (con't.)

suggest an age probably no older than Zone 12 for these poorly fossiliferous rocks.

AGE: Late Mississippian
(Probable Zone 12 to Zone 13)

ENVIRONMENT: Shelf (Restricted to Open Platform)

RE: Husky/USGS - Lisburne #1, North Slope, Alaska

REPEAT OF SECTION

PLATE 5

15,320-15,410'

Occurrences of Protonodosaria sp., Paleoaplysina sp., and frequent nodosariids indicate that these strata are probably Early Permian (A.W.A. F-21) in age.

Based on these findings, coupled with the findings on the overlying plates, it appears that Lithologic Unit E may be Late Permian to Early Triassic (F-20) age while Lithologic Unit F may be Early Permian (A.W.A. F-21) age.

AGE: Permo-Triassic
(Probable F-20 to F-21)

ENVIRONMENT: Possible Neritic (Shelf)

15,410-16,060'

These carbonates are much less recrystallized than they were on the overlying four plates. Occurrences of Trepeilopsis sp., Endothyra spp., Pseudoendothyra sp., Pseudoglomospira sp., Earlandia moderata, E. clavatula, Globoendothyra tomiliensis, G. spp., Brunsia pulchra, Calcisphaera pachysphaerica, Priscella prisca and questionable Eoendothyranopsis? sp. suggest a Late Mississippian (probable Zone 14 to Zone 16) age. These grainstones, packstones, wackestones and silicified limestones probably represent shallow carbonate shelf (open platform to bank) deposition. The dolomites found

RE: Husky/USGS - Lisburne #1, North Slope, Alaska

15,410-16,060' (con't.)

above 15,510 feet suggest some supratidal to restricted platform deposition.

AGE: Late Mississippian
(Probable Zone 14 to Zone 16)

ENVIRONMENT: Shelf (Supratidal to Bank)

16,060-16,680'

Endothyra bowmani group, Endothyra spp., Earlandia moderata, Earlandinella sp. (pl. 26), Globoendothyra tomiliensis, Calcisphaera pachysphaerica, Dainella anivikensis, Brunsia lenensis, B. irregularis, Eoendothyranopsis pressa-rara, E. spiroides, Paracaligelloides sp., Endothyranopsis compressa, Eoforschia moelleri, E. sp., Stacheia skimoensis, Koninckopora inflata, frequent to abundant coral wall debris and frequent to common ostracods are indicative of a Late Mississippian (Zone 12 to Zone 13) age. These relatively fossiliferous rocks probably represent open platform to bank deposition.

AGE: Late Mississippian
(Zone 12 to Zone 13)

ENVIRONMENT: Shelf (Open Platform to Bank)

16,680-17,000' T.D.

This interval is characterized by a reduction in fauna. The continued occurrence of frequent to common Stacheia skimoensis in Cores 19 and 20 suggests that these rocks are probably no older than Zone 12 in age. The rare occurrence of

RE: Husky/USGS - Lisburne #1, North Slope, Alaska

16,680-17,000' T.D. (con't.)

archaediscids in the ditch between 16,920 feet and 16,980 feet also suggests a Zone 12 or younger age. These strata probably represent restricted to open platform deposition.

AGE: Late Mississippian
(Probable Zone 12 to Zone 13)

ENVIRONMENT: Shelf (Restricted to Open Platform)

In summary we would like to caution the reader that the above biostratigraphic interpretation of the Lisburne #1 well is just that, an interpretation. In general, the faunal recoveries from this well were not the best. Due to facies changes faunal recoveries from specific lithologic intervals were not consistent on all plates.

Interpreted by:

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RE: Husky/USGS - Lisburne #1, North Slope, Alaska

APPENDIX A

Lithologic Study of Repeated Sections

This lithologic study is based on the examination of thin sections and washed lithology cuts from 361 samples covering the interval 6760 feet to 17,000 feet (total depth).

Lithologies of the five plates (repeated sections) examined to date are summarized on Appendix Charts 1, 2, 3, 4 and 5, and Appendix Figures 1, 2, 3, 4 and 5, respectively. In general, the five repeated sections examined thus far are similar with regard to stratigraphic sequence, facies and diagenetic alteration (recrystallization), with the exception of Unit G on Plate 5, which is much less recrystallized than on the overlying four plates.

Units A through F are lithologically very comparable between the upper three plates. Unit A was not repeated on Plate 3, however. Plate 3 started out in Unit B. Plate 4 started out in Unit E (or possibly basal Unit D). It is hard to tell in ditch samples, but the first two or three samples (13,370-13,460') of Plate 4 might represent the basal part of Unit D. Plate 5 started out in Unit F. In general, most of the units are the thinnest on Plate 1 and the thickest on Plate 2.

RE: Husky/USGS - Lisburne #1, North Slope, Alaska

Lith Unit	Plate 1	Plate 2	Plate 3	Plate 4	Plate 5
A	60'+	210'	-	-	-
B	120'	210'	150'	-	-
C	60'	60'	60'	-	-
D	210'	330'	180'	90'?	-
E	90'	150'	130'	150'	-
F	90'	90'	90'	120'	90'

Units D, E, and F appear to be fractured on Plate 3 as evidenced by the presence of vein calcite in samples from those units. These Permo-Triassic clastic and argillaceous limestone units appear to represent similar open marine outer shelf, slope and basinal deposits.

Unit G is very similar between the upper four plates with the exception that there is more dolomite found in Unit G on the third and fourth plates, suggesting a somewhat shallower depositional environment for these sections. This unit is characterized on the upper four plates by being almost totally recrystallized. Unit G is much less recrystallized on Plate 5 allowing for much greater faunal recovery. The thickness of Unit G does not vary more than 100 feet between the five plates.

Units H, I and J are relatively similar with respect to overall stratigraphic thickness and depositional environments, but do differ lithologically between plates, probably as a result of lateral facies changes associated with the restricted platform portions of Units H and I. It is very

difficult to differentiate Unit I on Plates 3 and 4, probably due to facies changes. Unit J appears to represent bank and open platform facies on each plate. A fair amount of dolomite, dolomite (oil stained?) and dolomitic limestone (oil stained?) occurs on all five plates associated with these three units (H, I and J).

Unit K, the last unit differentiated, occurs only on Plates 3, 4 and 5. This unit appears to represent interbedded restricted platform and open platform carbonates. Some occurrences of dolomite (oil stained?) are found associated with the upper portion of this interval. Unit K was thickest on Plate 3, although the lower depositional boundary was never penetrated on any of the plates.

In summary, all plates thus far penetrated appear very similar with respect to stratigraphic sequence, and unit thicknesses. Depositional facies of the units between plates is also very similar with the possible exception that the increased amount of dolomite found associated with Plates 3 and 4 may be due to a slightly shallower environmental position (i.e. more restricted platform and supratidal facies). Plate 3 also exhibits some diagenetic fracturing of Units D, E and F as evidenced by the presence of vein calcite throughout these strata.

RE: Husky/USGS - Lisburne #1, North Slope, Alaska

APPENDIX B

1-79-02 O/C

No Foraminifera found. Dark brownish-gray fine-grained sandstone.

AGE: Indeterminate
ENVIRONMENT: Indeterminate

9ABO-4 O/C

No Foraminifera found. Pyrite (R), coal (F), vein calcite? (FL). Buff tan calcite vein?

AGE: Indeterminate
ENVIRONMENT: Indeterminate

9BO-1 O/C

No Foraminifera found. Dark yellowish-brown fine to medium-grained sandstone.

AGE: Indeterminate
ENVIRONMENT: Indeterminate