A. Haeg
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B- File

File Cod

7

April 29, 1969

Core study of 7/11-1X and 3X wells and recommended Basin analysis, North Sea (Norway).

Mr. H. H. Heikkila
Oslo, Norway

Attached are the core descriptions and photographs of the Phillips 7/11-1X and 7/11-3X wells, North Sea (Norway). The sedimentary structures are similar to those in the 7/11-2X well previously described. They are typical turbidite sandstones and only serve to substantiate the interpretations made on the 7/11-2X core and covered in detail in my letters dated December 13 and March 21. Therefore I can not add any more information on the sedimentology of these wells except one point I failed to point out in the petrography section of the March 21 letter. In addition to the coarse-grained metamorphic and granitic source for the sands, there is evidence to suggest that a considerable amount of sand was derived from older sandstones. These older sandstones were probably coarse grained and rounded with some quartz overgrowth cement.

A very brief review of the geology of Scotland suggests that most of the rocks cropping out there consists of granulitic gneisses, mica schists, amphibolites and some sediments, all of Precambrian age plus Devonian Old Red Sandstones. Also, one magnetic map shows a basement high extending into the area northeast of Scotland and south of the Shetland Islands. This area may have been the source for the Paleocene sands.

The source and distribution of these turbidite sandstones in the basin will depend on the configuration and relief of the basin at the time of deposition and the location of the source area. These, in turn, are a product of tectonism and a knowledge of regional tectonic patterns is essential in order to analyze the development of the basin. Listed below are several methods of analysis which may be taken to determine the depositional patterns in the basin. Some of these steps have probably been done, and from several conferences with Bob Moseley and Roger Jackson, I understand that others are being considered. However, for completeness, I will list all methods which may be useful.

1. Regional structure maps of the basin. Maps on base of the chalk, top of the chalk, top of the Paleocene, plus other Tertiary horizons and base of the Zechstein, if data are available. The maps should cover the Norwegian sector plus the adjoining U. K. sector and extend as far north as data are available. Extension into the U. K. sector is important because of the suggested northwest source of the sands.

2. Isopach maps using both well and seismic data. The Tertiary should be divided as much as data allows in order to show any shift in the depocenter with time. These isopach maps used in conjunction with the structure maps may show the

growth periods of the salt structures and how they affected deposition of the turbidite sands. The isopachs may also show regional sand trends and possible source direction.

3. Use of the computer mapping program will make all of these maps available with minimum effort.

4. The quality of the reflecting horizons on the seismic profiles may give an indication of the sand content in the Tertiary intervals. Since it is reasonable to assume that the Tertiary is primarily a sand-shale sequence, a seismic section with good reflectors can be expected to have more interbeds of sand than a section which has poor reflecting horizons. This has been illustrated by Phillips Limon well in the Uraba basin, Colombia. In this area of the Uraba basin the seismic profile has only a few reflecting horizons which can be traced any distance. The electric log of the Limon well shows a stratigraphic section which is predominantly shale with two or three zones containing several sandstone beds 30 to 50 feet thick. When the electric log is correlated with the seismic profile the zones of sandstones match the zones of good reflecting horizons. If the quality of the reflectors in the Tertiary of the North Sea could be mapped it may give a crude picture of the sand distribution in the basin.

   A sand map constructed using only well data may not show a representative thickness of sand, since most of the wells are drilled on top of structures. The salt structures were probably growing during deposition of the sands, and if they had any topographic relief, the turbidite sands may have been concentrated in low areas on the flanks of the structures.

5. Literature review of the geology of England, Scotland, Norway and the islands at the north end of the North Sea. Particular attention should be devoted to the lithology of the outcrops and ages of tectonic events. This information plus mineralogy of the Tertiary sandstones will help determine source area. As mentioned in my previous letter the mineralogy of the sands suggests a source area consisting of coarse-grained metamorphic rocks, granite and older sandstones.

6. Finally, all of this data combined should give a logical geological history showing how the basin developed and how it was filled with sediment. Ideally this work in the Norwegian waters could be combined with the computer mapping work in progress in the Dutch and U. K. sectors. This combined work would give the complete geologic history of the entire North Sea basin from the Carboniferous Period through the Tertiary.

I realize that some of these suggestions have been done, some are in progress, and some may not be feasible due to lack of time and personnel. I will be glad to assist with interpretation of the maps or any other analyses if the need arises.

J. E. Webb
237-B FPB, Ext. 8056

JEW:bk
Attachm.
cc: L. M. Rickards
Silvio Eha (2)
M. E. Simons - A. Haig (w/attachm.)

Phillips 7/11-3X (Norway) North Sea

10,068'-10,111'6"	Shale, dk gray, interbedded with gray-siltstone and vf sandstone in sets mostly 1/4 to 1 inch thick. One set of vf (88µ) sandstone 1 ft. thick at 10,102 ft. Numerous graded sequences 1 to 2 inches thick. A few scattered fossils which appear to be odd-shaped fish scales. No burrows. One-foot zone with slickensides at 10,108 feet. All the interbedded silt and sandstone is very glauconitic.
10,111'6"-10,014'7"	No core
10,147'-10,153'	Sandstone, f (177µ) to c (750µ), mostly f (250µ) with coarser grains near the base of the unit. Has 2 inches of shale at top and 6 inches thin bedded silt and shale one foot above base. Sand is poorly sorted with some quartz overgrowths, slightly glauconitic, mottled by burrows, thin hairline laminae of carbonaceous material, one zone of convolute structures. Some burrows in the shale and silt. Clay balls in the lower sand unit.
10,153'-10,157'	Shale, dk gray with interbedded silt and vf, slightly glauconitic sandstone. Sandy layers near base have abundant very fine-grained carbonaceous material. Load cast at base of sand.
10,157'-10,187'	Sandstone, f (177µ) to vc (2mm), firm, slightly glauconitic, poorly sorted. Sedimentation units from 1 inch to 4 feet thick, mostly graded beds and structureless beds, some laminated, some mottled by burrows. Three to six inch shale breaks at 10,160, 175, 179, 180, 182, 184 feet, some rich in plant debris.
10,187'-10,368'	No core
10,368'-10,424'	Sandstone, similar to above but with more very coarse sand, some grains up to 3 mm, glauconitic, one scour at least 6 inches deep, one graded unit 4 feet thick with lamina and clay balls, abundant rather wavy horizontal lamina, one foot layer of interlaminated shale and siltstone at 10,387 feet.

Phillips 7/11-1X (Norway) North Sea

9589'-9618' .... Sandstone, f (125µ) to granule (3mm), poorly sorted, firm graded beds, glauconitic, less coarse material than in the 7/11-3X, graded beds not as well developed, much horizontal lamination, horizontal wavy lamination, one scour at 9612 ft. 6 inches deep, convolute bedding in the interbedded silt, interbedded silt layers up to 1 foot, mostly 2-3 inches. Sand layers up to 6 feet without silt break, very few clay layers, plant debris in thin lamina at 9630 and 9610 feet, red garnet visible, base of this interval is a sub-friable sand recovered in fragments.

9618'-9622' .... No core

9622'-9644' .... Sandstone as above

9644'-9688' .... No core

9688'-9701' .... Sandstone, f (125µ) to vf, hard, quartz cement, some porosity, fractured, slumped. Fractured and slickensided shale at base of sand.

PHILLIPS 66

P. O. Box 51185
Lafayette, Louisiana 70501

INTER-OFFICE CORRESPONDENCE / SUBJECT:

February 5, 1969

Re: Phillips (Norway) 7/11-~~2X~~ 1X fw
North Sea Well

Mr. J. E. Webb
237-B Frank Phillips Building
Bartlesville Office

Enclosed (on Robertson charts fw) are the inferred environments and relative rates of sedimentations you wanted. In the absence of any population estimates, I have based the sedimentation rates on the number of species listed, and the environments on the presence of certain facies markers. Material caving from above could cause some of the determinations to be erroneous, but the Robertson staff seems to have eliminated much of this caved material from their consideration or there was only an insignificant amount.

Some of the species reported I was unfamiliar with and had no literature on them. A knowledge of these species could alter a few of the determinations, but overall, this knowledge would only confirm.

In the Pleistocene to Middle Miocene, the determinations indicated could be inaccurate. These sediments may be masked VII (or VIII?). The shallow water fossils could be displaced faunas.

The facies and relative rates of sedimentation are marked on the Robertson Analysis Chart.

Walt

WALTER H. TRENCHARD

WHT:jb

Enclosure

Sent copy to Jack Lewis
2-13-69 - RWR.

February 5, 1969

PHILLIPS (NORWAY) 7/11-~~2X~~ 1X
NORTH SEA WELL

Plio-Pleistocene

Fauna was perhaps masked by a high rate of sedimentation and may belong to a slope facies (re: VII or VIII). *Nonion soldanii* in the Robertson report is likely to be *Nonion pompilioides*. These species are very close. If so, this material should be placed in VII, at least. There is still another similar form, *N. barleeanum*, found on the shelf.

Miocene

There could be some shoaling in the Upper Miocene or masking of fauna by sediments. Assuming the latter, these should be assigned to VII, at least. Below 4040 feet the fauna is definite VII. Below 4660 feet the well penetrated VIII and appears to remain in VIII until 9420 feet in Paleocene.

Below 8300 feet the increased sedimentation and the dominance of agglutinated forms indicates an increase in delta building to the landward. This could mean a bird's foot delta in the vicinity dumping its sediments into deep water, but subaerial portion of the delta might be some distance away, depending on the nature of the marine currents. Increased storm activity might give us a similar picture, but we should have more fluctuation in the rate of sedimentation if this was so.

Oligocene

Rate of sedimentation was high, but less than in the Miocene. The deltaic (?) influence was less significant.

Eocene

Increased sedimentation compared ~~to~~ Oligocene. More delta activity?

Paleocene

Below the top of the Paleocene, we are interpolating excessively. Although these older beds are subject to the same principles of paleocology as the younger, more experience is needed to interpret the facies correctly.

The Paleocene appears to have had some shoaling, but this may be masking of fauna by sedimentation. I suspect the latter, although I indicated shoaling which may have resulted from uplift.

In the Danian, Facies VIII is again encountered and the rate is higher than in the Paleocene, although somewhat more sporadic.

Cretaceous

The fauna indicates very little, but most of the fossils are planktonic. The limestone could be of biogenic origin, shallow or deep water. Strictly a guess, but this could be basinal limestone seaward of a biostrome or bioherm, or a planktonic ooze in which most of the fauna suffered destruction. If a basinal limestone, the high rate of sedimentation inhibits the fauna and it should be assigned VIII-2; if planktonic ooze, deeper than VIII-9. Chemical deposition is also a possibility.

If we assume a shallow water origin for the limestone with destruction of fauna, then there would have to be rapid downwarping during the Maestrichtian (4000+ feet). A fair case for downwarping could be made on the basis of the Paleocene lighology, but I don't believe the fauna indicates this.

The absence of some Cretaceous beds does not necessarily indicate erosion. The absence could be explained by non-deposition or lack of faunal development or preservation.

Jurassic - Cretaceous

The absence of Foraminifera is probably the result of high salinity which would repress or prohibit the development of typical marine fauna.

Permian

The Robertson report implies or tacitly assumes shallow water deposition for the salt. I favor deep water deposition at the well site. There is no evidence in the overlying beds to positively support shallow water deposition and nothing to indicate Cretaceous downwarping in excess of 4000 feet.

Walter H. Trenchard

WALTER H. TRENCHARD

WHT:jb

INTER-OFFICE CORRESPONDENCE / SUBJECT:

P. O. Box 51185
Lafayette, Louisiana 70501

February 10, 1969

Mr. Don Dalrymple
257 Frank Phillips Building
Bartlesville Office

Enclosed are charts used for facies and relative rates of sedimentation you requested. These do not represent the entire picture.

In areas or zones where the rate of sedimentation is high, we find it necessary to employ rare specimens and the nature of the adjacent faunas above and below, for facies determination.

In areas or zones where "normal" conditions exist, we usually employ a minimum of 10 specimens of a given facies marker species for assigning facies. This number is usually satisfactory to take care of cavings from above and enable us to recognize shoaling in many cases. Shoaling is always difficult to ascertain, because it may be only a change in the rate of sedimentation. On the shelf, changes in the rate of sedimentation probably produce changes in facies which result from shoaling or deepening, but on the slope, it often takes a considerable amount of shoaling or uplift, etc. to produce a change of facies number.

Further, reworked and displaced faunas can introduce errors which can prevent all determinations of facies and sedimentation just as can excessive cavings from above. Population studies, though tedious, can frequently rectify such errors, but not always. These alien additions are usually troublesome and we have no completely satisfactory means of correction for them.

The figures on the relative rate of sedimentation represent orders of magnitude rather than precise numbers.

Also enclosed is a reprint of my recent paper in the GCAGS Transactions which may be helpful.

Thank you for your interest in the facies work. If you have any questions, please let us know.

Walter H. Trenchard
WALTER H. TRENCHARD

WHT:jb

Enclosure

P.S. - Bathymetry is incidental. Facies are related to relative distance to the shore-line. Depths, when used, represent orders of magnitude only.

R - 4-9
F - 10-20
C - 26-50
Vc - 50-200
A - 200-500

April 1, 1966 2-11-6

II Orange 372
III Burnt Sienna 398
IV Apple green 389
V Light green 392
VI Azure 393
VII Light blue 394
VIII Violet 377

ENVIRONMENTAL FACIES
(Mainly Miocene-Oligocene

I Continental Facies — Motif 6002 Carmine Dixon 370 Red

A. Non-fossiliferous redbeds

1. For our purposes, we probably will have to rely on an absence of fossils to identify these beds, when these beds are in association with lagoonal beds.

II Transitional facies 6013 Orange Dixon 372 Orange

A. Lagoonal beds

1. Red or green clays with some sand.
2. Fossils:

Rotalia beccarii
Elphidium spp. (E. gunteri, E. incertum are examples)
Charophyta
Rangia johnsoni
Rangia cuneata
Eponidella cushmani
Ammotium salsam
Shell fragments of various mollusks
Oyster
Potamides matsoni

Burnt Sienna Dixon 398

III Inner Shelf facies ~~6021 Sky Blue~~ ~~Dixon 393 Azure~~

A. Characterized by weakly developed marine assemblage including forms from the above facies. A few of the species below will be present.

Textularia sp. VR-C
Quinqueloculina seminula (VR-C
Quinqueloculina spp. VR-C
Robulus americanus V-C
Robulus iotus VR-R
Nonionella auris VR-C
Nonionella hantkeni spissa VR-C
Elphidium spp. VR-C
Discorbis spp. VR-C
Eponides antillarum VR-C
Rotalia beccarii VR-A
Planktonic forms VR-R
Cibicides spp. VR-C
Siphonina jacksonensis ~~VR-C~~ limbosus VR-C
Amphistegina spp. VR-C
Planktonic-Benthonic ratio: less than 0.1

Dixon 389 Apple Green

Dixon 394 Light blue

IV Middle shelf facies 6031 True Blue
A. is characterized by a well developed marine in which the planktonic forms are common to very common. This facies will contain forms from the above facies.
B. The following species are present in this facies:
Textularia spp VR-C
Quinqueloculina spp. VR-C
Robulus americanus VR-C
Robulus iotus VR-C
Robulus spp. VR-VC
Robulus vaughani VR-C
Guttulina problema VR
Nonionionella hantkeni spissa VR-VC
Elphidium spp. VR
Uvigerina pilulata VR-R
Discorbis spp. VR-A
Eponides antillarum VR-A
Rotalia beccarii VR-A
Planktonic-Benthonic ratio: 0.1-1.0

Dixon 392 Light (~~382 Apple Green~~)

V Outer shelf facies 6001 Blue Dixon 376 Blue
A. The outer shelf facies contains a prolific marine assemblage with numerous species. The family Buliminidae is prominently represented in this facies. Forms from the previous facies will occur and will tend to be larger in this facies.
Liebusella byramensis VR-C
Eggerella (VR-F)
Quinqueloculina spp. VR-C
Robulus chambersi C-VC
Robulus iotus VR-C
Robulus spp VR-VC
Robulus vaughani VR-VC
Marginulina sublituus VR
Saracenaria schencki VR
Nonionella hantkeni spissa C-A
Buliminella curta VR-VC
Bulimina gracilis VR-VC
Bulimina ovata (small) VR-VC
Virgulina pontoni VR-VC
Bolivina gladius VR-C
Bolivina marginata VR-VC
Bolivina marginata multicostata VR-A
Bolivina spp. VR-VC
Bifarina vicksburgensis monsouri VR-C
Bolivina mexicana VR
Uvigerina howei VR-VC
Uvigerina pilulata C-A
Ellipsonodosaria verneuili emaciata VR-C
Discorbis bolivarensis VR-VC
Discorbis gravelli VR-C

Discorbis nomada VR-C
Discorbis spp. C-VC
Eponides antillarum VR-A
Eponides ellisorae VR-A
Rotalia beccarii R-VC
Siphonina davisi VR-C
Siphonina jacksonensis limbosus C-A
Cassidulina crassa VR-R
Cassidulina subglobosa VR-R
Planktonics C-A
Planulina palmerae VR-R
Cibicides americanus R-C
Cibicides concentricus R-C
Cibicides floridanus (small) VR-C
Siphogenerina lamellata VR-R
Cyclammina cancellata (small) VR-R
Gyroidina vicksburgensis hannai VR-VC
Planktonic-Benthonic Ratio: 1.0+

Dixon 393 Azure Light green
Dixon 389 Apple Gree
6037 Apple Green

VI . Shelf-edge facies (Beginning of "deep water")

A. Is characterized by a prolific assemblage of Foraminifera with numerous species that are noticeably larger than before. Siphogenerina lamellata, Cyclammina cancellata, Uvigerina israelskyi, Uvigerina lirettensis, Liebusella byramensis are often very common here and may occasionally flood. Planktonics will usually be abundant. "Deep Water" forams begin to appear. This facies is associated with the "hinge line" features.

Underscored forms are facies markers

A { Liebusella byramensis VR-A
A { Cyclamina cancellata VR-A (small)
B Siphogenerina lamellata VR-A
Uvigerina peregrina VR-A
Cassidulina subglobosa VR-VC
C { Uvigerina lirettensis VR-VC
C { Uvigerina israelskyi VR-A
Buliminella curta VR-A
E Bulimina ovata VR-VC (medium) E
D { Discorbis "d" types VR-A
E { Bolivina mexicana VR-A
Uvigerina howei VR-Flood
Uvigerina pilulata VR-Flood
Gyroidina danvillensis VR-A
Gyroidina Vicksburgensis hannai VR-A
Bulimina ovata (lge.) VR-C
Siphonina spp. (lge.)
Planktonic-Benthonic ratio: 1.0-5.0
and others from previous facies very rare to rare deep water species, which are usually dwarfed are small size.

B { Uvigerina israelskyi C-A
B { Siphogenerina texana C-A
Cibicides opima VC-A
Robulus "L" VC-A)
Robulus latona* VC-A
Eggerella (C-A)
Anomalina bilateralis
Volvulina (F-A)

Dixon [illegible]
Dixon 414 Viridian
6024 Emerald Green
6014 Light Green

VII Upper slope facies

A. Is characterized by a great abundance of fauna. Many forms found on the shelf become rare on the slope, although they may be fairly common locally. Deep water forms are fairly common but may be of smallsize, increasing in size and abundance seaward. Gyroidina scalata and Nonion lunatum are usually common. Cibicides floridanus is usually large and quite common. Planktonics usually in Flood.

Ammobaculities nummus (VR)
Cyclammina cancellata VR-A (lge)
Liebusella byramensis VR-R
Siphogenerina lamellata VR-Flood
Uvigerina lirettensis VR-A
Uvigerina canariensis VR-A
Valvulineria texana VR-A (small)
Gyroidina scalata VR-C
Nonion lunatum VR-C
Anomalina bilateralis anabuacana VR-A
Planulina D VR-C
Planulina harangensis VR-C
Cibicides floridanus VR-A
Robulus budensis VR-R
Gyroidina soldanii VR-R (Small-medium)
Textularia tatumi VR-C
Textulariella barrettii VR-C
~~[illegible]~~
Pseudoglandulina comatula VR-C (Small)
Sphaeroidina variabilis VR-C (Small)
Epistomina elegans VR-C (Small?)
Ceratobulimina sp. VR-R
Nonion pompiliodes VR-R
Pullenia bulloides VR-R

Bulimina bleekeri [illegible] A
Gs B
Nn C
Pocem D?
Sphv D?
Np D?
Ecr D?
Bol tectiformis
Bolivina alazanensis

Eponides crebbsi VR-F 7D

Eponides umbonatus
U. hispida (small)
Bulimina ovata (lgs) VR-V(
Planktonic-Benthonic Ratio: 1.0-5.0+

VIII Lower Slope facies

6024 ~~Emerald Green~~
[illegible] 6024 Green
Dixon ~~334~~ 377 violet

A. Is characterized by a well developed populous deep water assemblage with a flood of planktonic forms. A few forms are not found in any other facies: Verneuilina mexicana, Ammospirata mexicana, Anomalina alazanensis. Cibicides mexicanus Sigmoidella sp.

Dixon ~~392~~ Light green

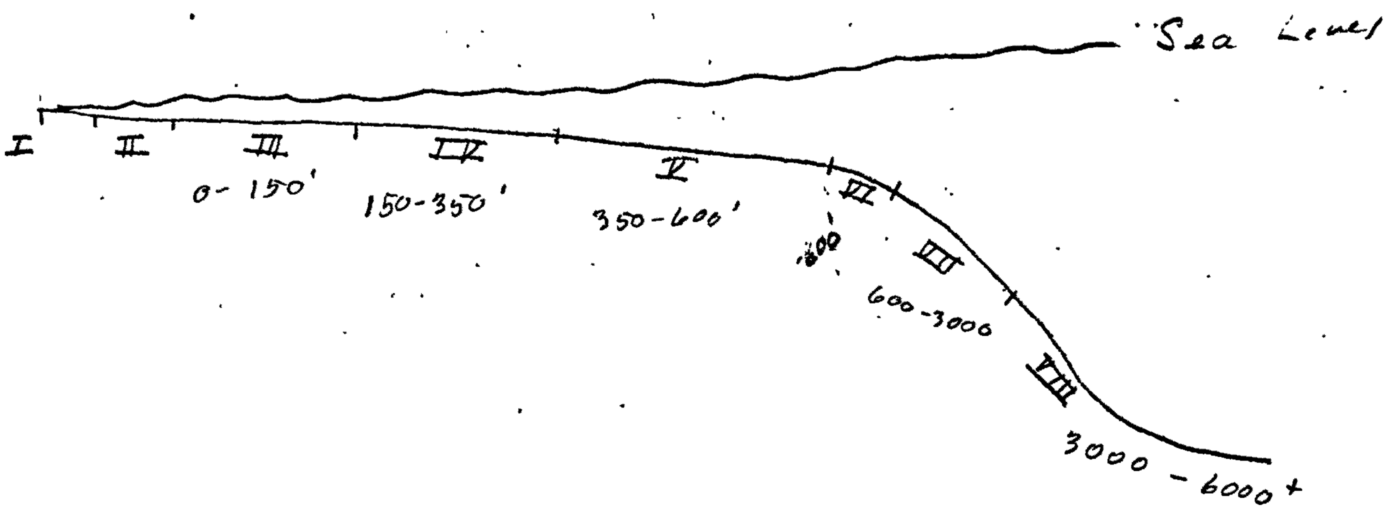
The forms below particularly characterize this facies:

Gyroidina scalata VR-A (Large)
Gyroidina soldanii VR-VC (Large)
Pseudoglandulina comatula VR-VC (large)
Eponides crebbsi VR-VC [illegible] VII or VIII
Sphaeroidina variabilis VR-VC (large)
Epistomina elegans VR-VC
Ceratobulimina sp. VR-C
Nonion pompilioides VR-VC
Pullenia bulloides VR-C

Ehrenbergina sp VR-
Parella [illegible]
Cib. perlucida
Cib. mexicana

Deltaic facies can occur in any and all marine facies. Generally, marked high rates of sedimentation + agglutinated forams

Verneuilina mexicana VR-C
Uvigerina hispida VR-C ?
Ammospirata mexicana VR-C?
Valvulina(?) texana (Large) VR-C
Anomalina alazanensis VR-C
Anomalina mecatepecensis VR
Cibicides mexicana VR-C?Position uncertain
Planktonic-Benthonic Ratio: 10±



Relative Rate of Sedimentation

Rate	1	2	3	4	5	6	7	8
Total Population	0	10	40	250	1500	6500	15000	25000
Benthonic Population	0	10	40	250	1000	2500	3000	3000
Planktonic Population	0	VR-R	R-F	F-VC	A-VA	VA-Flood	→	→
Species	0	less than 5	5	10	25	50	50	50
% Planktonic	0	5%	10-20%	20-30%	50%	60%	80%	90%