

PS Neogene Biostratigraphy and Sea Level Changes — Case Study from North Kuwait Field*

**Prasanta K. Mishra¹, Bibi H. Akbar¹, Khalid Ahmed¹, Pradeep K. Choudhary¹,
Ferdous Hassan¹, Stephen Packer², Stephen P. Starkie², and Darrin T. Stead²**

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¹Kuwait Oil Company, Ahmadi, Kuwait (miogypsina@yahoo.com)

²Millenia Stratigraphic Consultants, Buckinghamshire, United Kingdom

Abstract

The Neogene clastics (sandstones and shale interventions) in one of the north Kuwait fields range in age from Early Miocene (Burdigalian) to Middle Miocene (Serravalian). An attempt was made to carry out detailed biostratigraphy (foraminifera, nannoplankton, palynomorphs and dinoflagellate cysts) from study of selected core samples in this geological succession and establish the sea level changes and depositional environment leading to sequence stratigraphic interpretations.

The bottom most sands are devoid of any microfossils and inferred to be deposited in a fluvial channel facies. The first basal transgression corresponds to the prominent intermediate Shale layer between two reservoir sands and an abundance of Dinocysts, influx of *Pediastrum* sp was observed. The sediments are inferred to have been deposited in an inner neritic regime. This is followed by a swallowing trend of sea level in the immediate upper layers grading towards transitional/non marine conditions.

The definite indications of Early Miocene (Burdigalian) transgression are evidenced from microfossils from the first Shale with the record of *H. Cinctum* and palynomorphs viz. *S. ramosus* and smaller benthic foraminifera. A large influx of benthic foraminifers viz. *Dendritina* sp indicated an increase in sea level from up to the Middle Neritic conditions.

The topmost prominent transgressive succession prevailed over is the Serravalian (Middle Miocene), corresponding to the upper most Shale succession. The bottom part of this thick shale layer is rich in benthic foraminifera, Miogypsinids, rare planktics viz. *Globigerina* sp, *G. priamendardii* and nannoplankton species, *Sphenolithus heteromorphus* and a strong influx of dinoflagellate cysts. A middle neritic bathymetry was inferred at the bottom of the upper shale, which gradually shallowed to inner neritic conditions at the top of this shale. Thus, the maximum flooding surface was inferred at the bottom of the upper most shale. Fresh water influx was inferred at the top of the upper shale as supported from the occurrence of diatoms, Botryococcus pediastrum and ferruginous layers in the cores.

The reservoir sands are more or less distributed in between the transgressive episodes in an inter-distributary bay /lagoonal deposits. Integration with electrolog and sedimentological inputs was attempted to decipher the variation of reservoir facies in the study area.

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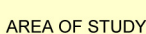
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An overall deepening trend is observed in the paleo bathymetry from bottom of the studied section (CH) to top (OS) in the three studied wells. Some of the salient features observed are-

The channel-fill deposits consist of stacked, finely-grained, and clean to argillaceous sandstones, commonly with an erosive pebbly base. These deposits present dominantly high-angle cross bedding that can reflect the migration of bed forms under low-flow-regime conditions. The deposits typically display a blocky low gamma response and sand-prone neutron density crossover. These are the dominant deposits in the study wells (respectively 66.6%, 66.6% and 69.9% in Well-0003, 0004 and -0005). Biostriatigraphical and palynological measurements in the channel deposits are generally characterized by freshwater algae (*Botryococcus* and *Pediastrum*) and/or continental palynomorphs (spores and pollens), supporting a fluvial origin.

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The floodplain deposits consists of mainly mudrocks and heterolithic and rare argillaceous sandstone, locally bioturbated and pedogenetically modified with calcareite/dolomite nodules, roots and carbonaceous/plant debris. These characteristics suggest suspension deposition in a low-energy setting with phases of plant colonization. The deposits typically contain continental palynomorphs such as spores and pollens. The mud-prone character of the deposits is reflected by a classical high gamma response and mud-prone neutron density cross-over. They are classically not abundant across the study wells (Well-0003 = 8.4%, Well -0004 = 8.1% and Well -0005 = 6.1%).

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The molluscan deposits consist of clots to argillaceous, locally coarsening-upward, horizontally bedded sandstones that may reflect a progradational depositional style, under upper-fair-regime conditions. Bioturbation is of moderate abundance but typically impoverished in terms of assemblage. The deposits mostly contain rare biostatigraphical and palynological specimens that are generally microfossils and rare calcareous foraminiferids. Due to the variable mud-rich character of sandstones, the gamma ray signature is also variable, but neutron-density often displays a mud-prone type separation. These are poorly represented in the three study wells (Well-0003 = 7.5%, Well-0004 = 5.2% and Well-0005 = 4.8%).

[illegible]

The intertidary/bathyal bryalgaeno deposits comprise alternations of mudrocks/siltrocks and argillaceous sandstones with clay draped ripple lamination and variably diverse vertical and horizontal tubification, consistent with deposition under general low-energy conditions. The biostratigraphical and palynological content of the bryalgaeno is variable but it contains the most diversity with presence of both agglutinated and calcareous foraminifera, microfossils, dinocysts and rare *Botrivicoccus* and *Pediastrum*. The facies is characterised by irregular, high gamma and an irregular mud-prone neutral-density separation. These deposits are relatively well represented in the three study wells (Well -0003 = 13.1%, Well -0004 = 20.1% and Well -0005 = 16.0%).

[illegible]

The lower shoreface deposits consist of bioturbated sandstones with abundant burrows and bioclastic debris. These characteristics together with the sharp increase in calcareous benthic foraminifera shown by biostratigraphical data favour an open marine, moderate energy shoreface depositional setting. The deposits display a typical low gamma response but with a relatively wide mud-prone zone. They are tentatively absent in Well -0004 and Well -0005 and rare in Well -0003 (3.2%).

The lower shoreline deposits consist of unbedded sandstones with abundant burrows and bioturbation voids. These characteristics together with the sharp increase in calcareous benthic foraminifera shown by biostratigraphic data favour an open marine, moderate energy/shoreface depositional setting. The deposits display a typical low gamma-ray response but with a relatively wide mid-profile bed.

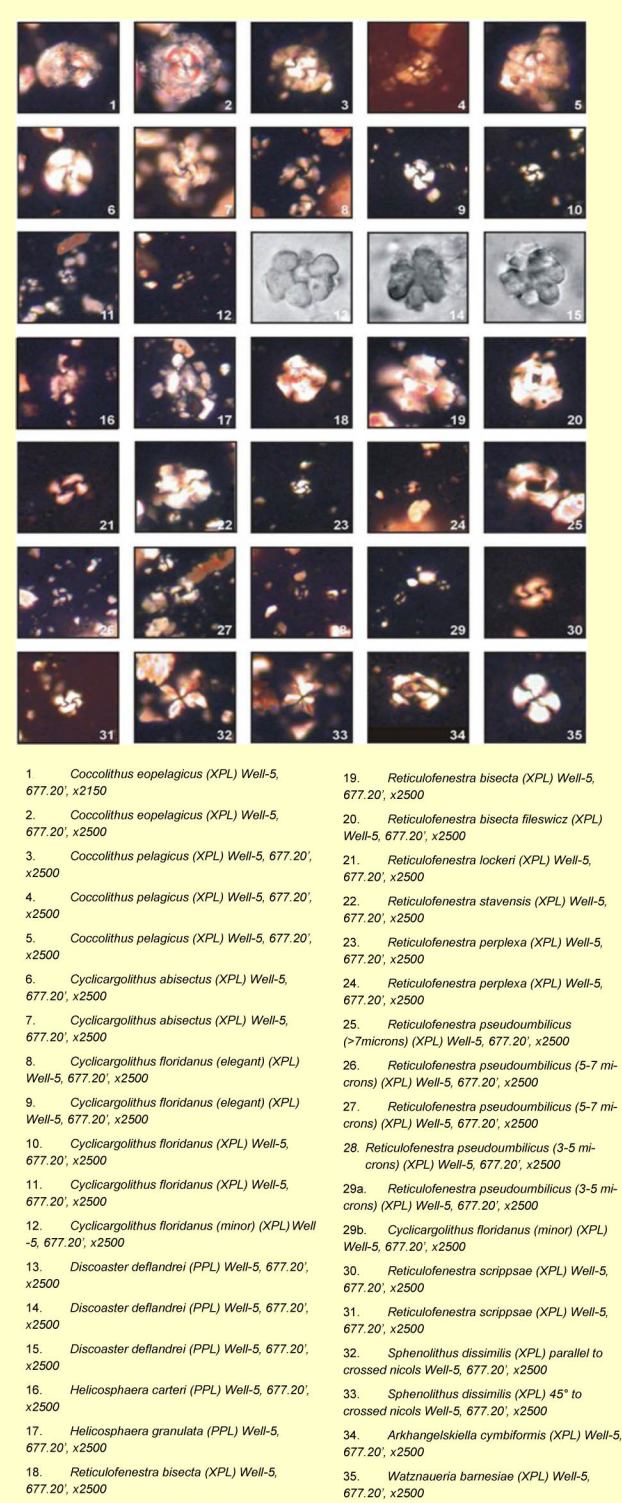
The offshore deposits present massive mudrocks/siltrocks that suggest deposition in a low-energy environment. However, the paucity of bioturbation may reflect stressed conditions and the biostratigraphical and palynological data are essential to distinguish this facies from interdistributary bay/lagoon as it can contain a high abundance of dinocysts typical of open marine conditions. Offshore log signature is classical with high nmr, rai and mudstone neutron density, gdpes, over. These densities are absent in wells Well_Hell_0004 and well_rain in wells Myel_0003 and Well_0005.

The ostracode deposits present massive mudrocks/shalloos that suggest deposition in a low-energy environment. However, the paucity of bioturbation may reflect stressed conditions. The biostratigraphical and palynological data are essential to distinguish this facies from intertidal/brackish bay/marginal as it can contain a high abundance of dinofossils typical of open marine conditions. Ostracode log signature is classical with high massive ray and mud-nodules neutron density *crust-ward*. These densities are absent in walls Wall -0004 and vary rare in walls Wall -0003 and Wall -0005.

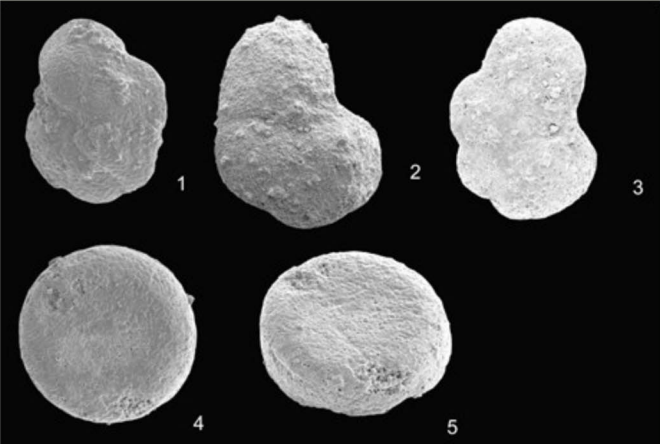
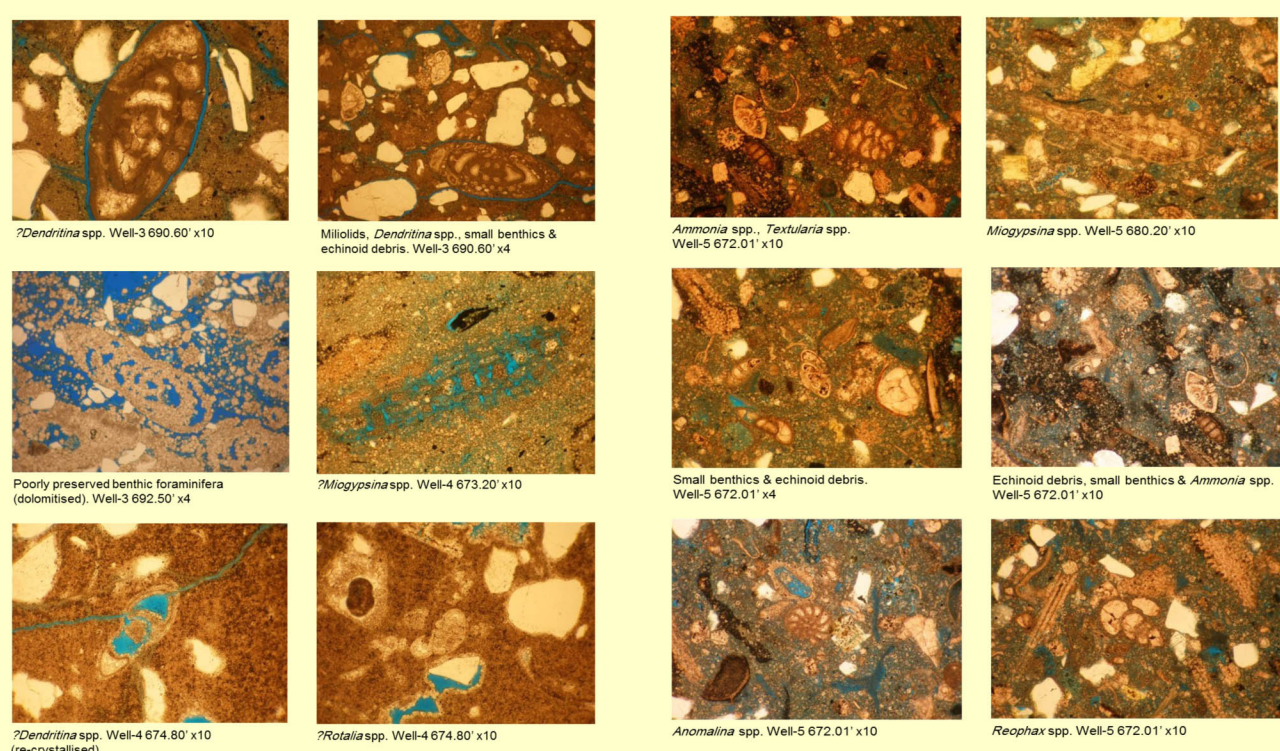
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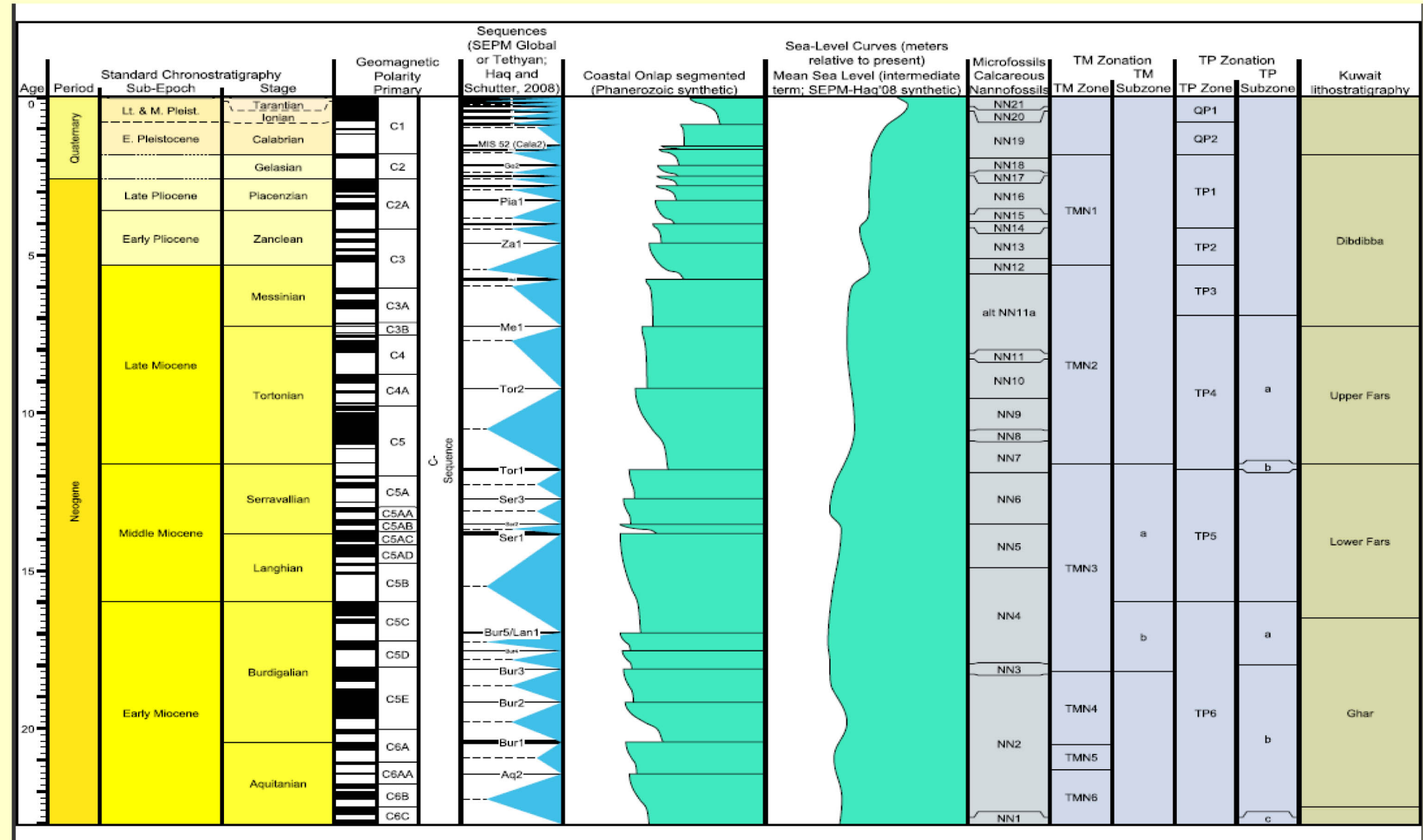
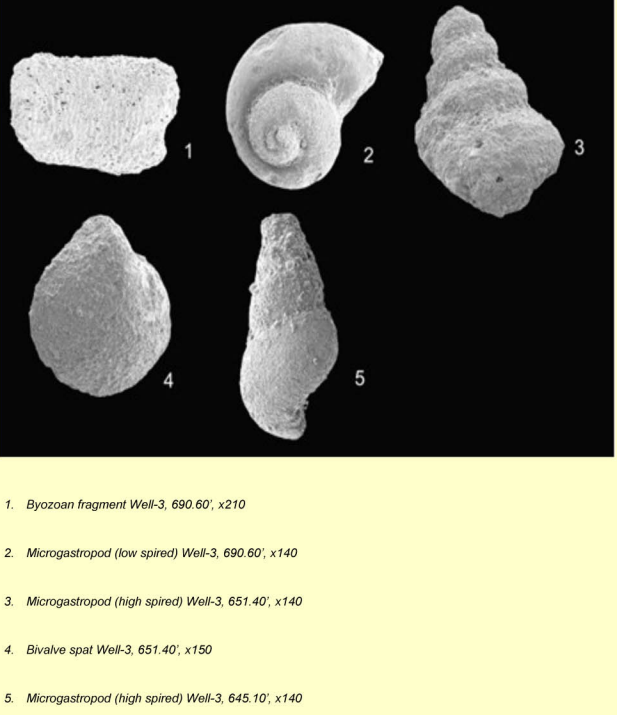
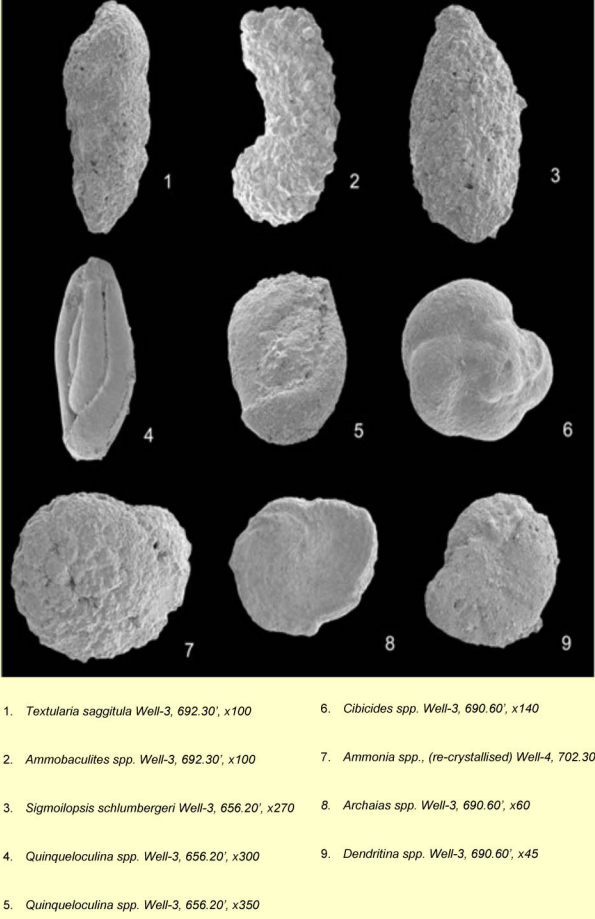
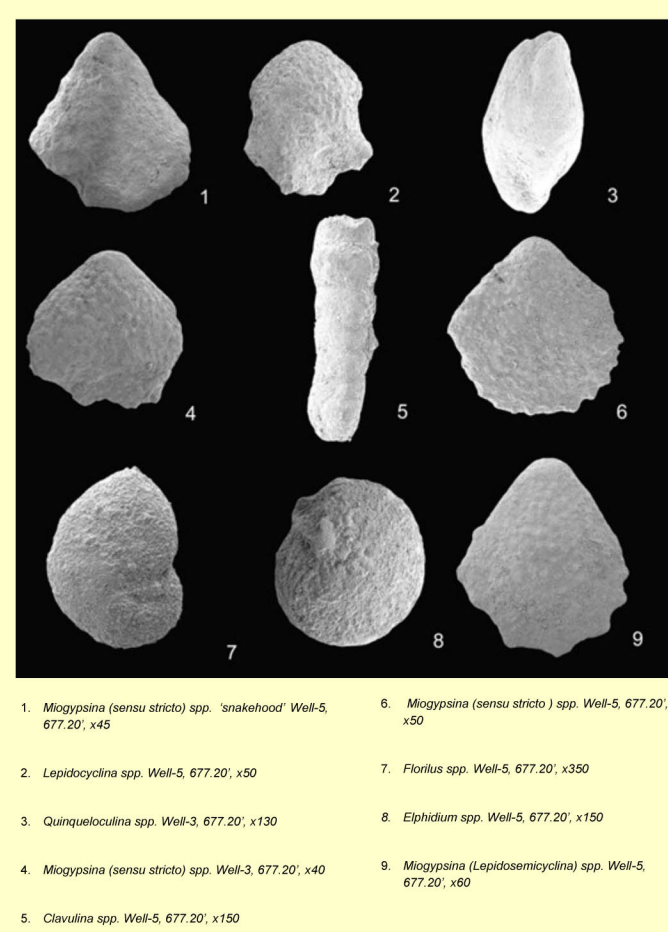
NANNO FOSSILS



MICROFOSSILS IN THINSECTIONS



MICROFOSSILS IN SEM



NEOGENE BIOZONATION OF KUWAIT

Summary

Chronostratigraphic and palaeoenvironmental interpretations are provided for each well section. Microfaunal recovery is variable though the sampled intervals, with localised peaks in foraminiferal abundance, notably in the base of the 'BA1(TOP SHALE) Layer. Nannofossil recovery is poor throughout, with most samples found to be barren, though an influx of taxa occurs at the base of the 'BA1' interval in Well-005, associated with a gamma peak. Palynological recovery is also variable, as with the other two disciplines the strongest marine influxes occur at the base of the clay rich interval. The sands do also yield some clear freshwater derived taxa, and localised marine influxes.

Keywords: Miocene, , chronostratigraphy, stratigraphy, micropalaeontology, nannopalaeontology, palynology, palaeoenvironments, foraminifera.