

Middle-Late Jurassic		late Albian		late Albiensis	Time unit
Masajid Formation		Burg El Arab Formation (Kharita Member)		Bahariya Fm.	Rock unit
	Depth (ft)	Sample number	INCERTAE SEDIS		
6150	66	5360	1		
6140	65	5370	2		
6130	64	5390	3		
6120	63	5400	4		
6110	62	5410	5		
6100	61	5420	6		
6090	60	5430	7		
6080	59	5440	8		
6070	58	5450	9		
6060	57	5460	10		
6050	56	5470	11		
6040	55	5490	13		
6030	54	5500	14		
6020	53	5510	15		
6010	52	5530	17		
6000	51	5550	19		
5990	50	5560	20		
5980	49	5570	21		
5970	48	5590	22		
5960	47	5600	23		
5950	46	5650	24		
5940	45	5660	25		
5930	44	5670	26		
5920	43	5680	27		
5910	42	5690	28		
5900	41	5700	29		
5890	40	5710	30		
5880	39	5730	31		
5870	38	5740	32		
5860	37	5750	33		
5850	36	5760	34		
5840	35	5790	37		
5830	34	5800	38		
5820	33	5820	39		
5810	32	5830	40		
5800	31	5840	41		
5790	30	5860	43		
5780	29	5880	45		
5770	28	5890	46		
5760	27	5900	47		
5750	26	5910	48		
5740	25	5920	49		
5730	24	5930	50		
5720	23	5940	51		
5710	22	5950	52		
5700	21	6030	55		
5690	20	6040	56		
5680	19	6050	57		
5670	18	6060	58		
5660	17	6070	59		
5650	16	6080	60		
5640	15	6090	61		
5630	14	6100	62		
5620	13	6110	63		
5610	12	6120	64		
5600	11	6140	65		
5590	10	6150	66		

Single (S) 1
Rare (R) 2-4
Common (C) 5-9
Abundant (A) 10-20
Very abundant (V) > 20

Figure 4.3. (continued).

Middle-Late Jurassic			late Albian															Time unit			
Masajid Formation			Burg El Arab Formation (Kharita Member)															Rock unit			
			Bahariya Fm.																Depth (ft)	Sample number	
			5360	1																	MICROSPORES
			5370	2																	<i>Triplanosporites</i> sp.
			5390	3																	<i>Concavosporites</i> sp.
			5400	4																	<i>Dictyophyllidites harrisi</i>
			5410	5																	<i>Gleicheniidites senonicus</i>
			5420	6																	<i>Deltoidospora mesozoica</i>
			5430	7																	<i>Cicatricosisporites orbiculatus</i>
			5440	8																	<i>Crybelosporites pannuceus</i>
			5450	9																	<i>Trilobosporites laevigatus</i>
			5460	10																	<i>Maonisporites crassangulatus</i>
			5470	11																	<i>Deltoidospora minor</i>
			5490	13																	<i>Cicatricosisporites</i> sp.
			5500	14																	<i>Cicatricosisporites minutistriatus</i>
			5510	15																	<i>Punctatisporites globosus</i>
			5530	17																	<i>Punctatisporites couperi</i>
			5550	19																	<i>Stereosporites antiquasporites</i>
			5560	20																	<i>Cicatricosisporites pseudotripuritus</i>
			5578	21																	<i>Leptolepidites psarosus</i>
			5590	22																	<i>Verrucosisporites rotundus</i>
			5600	23																	<i>Gemmariletes clavatus</i>
			5650	24																	<i>Lycospora</i> sp.
			5660	25																	<i>Microreticulatisporites uniformis</i>
			5670	26																	<i>Undulatisporites pannuceus</i>
			5680	27																	<i>Rugulatisporites</i> sp.
			5690	28																	<i>Cicatricosisporites hallei</i>
			5700	29																	<i>Punctatisporites</i> sp.
			5710	30																	<i>Osmundacidites wellmanii</i>
			5730	31																	<i>Paraconavisporites reissingeri</i>
			5740	32																	<i>Verrucosisporites obscurilaeus</i>
			5750	33																	<i>Laevigatosporites</i> sp.
			5760	34																	<i>Cibotiumspora jurienensis</i>
			5790	37																	<i>Biretisporites potoniei</i>
			5800	38																	<i>Neoraisackia truncata</i>
			5820	39																	<i>Cicatricosisporites dorogensis</i>
			5830	40																	<i>Deltoidospora hallii</i>
			5840	41																	<i>Lycopodiacidites cerebriformis</i>
			5860	43																	<i>Gemmariletes densigemmatus</i> (n. sp.)
			5880	45																	GYMNOSPERM POLLEN
			5890	46																	<i>Cycadopites</i> spp.
			5900	47																	<i>Araucarioxylon australe</i>
			5910	48																	<i>Corollina torosa</i>
			5920	49																	<i>Eucommiidites troedsonii</i>
			5930	50																	<i>Equisetosporites tortuosus</i>
			5940	51																	<i>Equisetosporites regularis</i>
			5950	52																	
			6030	55																	
			6040	56																	
			6050	57																	
			6060	58																	
			6070	59																	
			6080	60																	
			6090	61																	
			6100	62																	
			6110	63																	
			6120	64																	
			6140	65																	
			6150	66																	

Figure 4.4. Stratigraphic distribution of the recorded palynomorphs in the studied interval of the Sharib-1X well.

Middle-Late Jurassic			late Albian		Time unit
Masajid Formation			Burg El Arab Formation (Kharita Member)		Rock unit
			Bahariya Fm.		Depth (ft)
					Sample number
					INCERTAE SEDIS
					<i>Elatosporites kiasii</i>
					<i>Reyrea polymorpha</i>
					<i>Elatocarpites castelani</i>
					<i>Galeacoma causea</i>
					<i>Sofrepites legouxae</i>
					<i>Elatropilicites africanaensis</i>
					FRESHWATER ALGAE
					<i>Ovoidites parvus</i>
					<i>Ovoidites</i> sp. cf. <i>O. parvus</i>
					<i>Ovoidites spriggii</i>
					<i>Ovoidites australiensis</i>
					MICROPLANKTON
					<i>Palaeoperidinium cretaceum</i>
					<i>Oligosphaeridium complex</i>
					<i>Nexosipinum</i> sp.
					<i>Spiniferites ramosus</i>
					<i>Downiesphaeridium aciculare</i>
					<i>Downiesphaeridium spinulatum</i>
					<i>Dinopterygium cladoides</i>
					<i>Cyclonephalium</i> spp.
					<i>Florentinia cooksoniae</i>
					<i>Hysterochodinium pulchrum</i>
					<i>Subtilisphaera zawia</i>
					<i>Florentinia khalidunii</i>
					<i>Aptodinium apiatum</i>
					<i>Aptodinium granulatum</i>
					<i>Pterodinium cingulatum</i>
					<i>Gonyaulacysta</i> sp.
					<i>Florentinia</i> sp.
					<i>Coronifera oceanica</i>
					<i>Systematophora ?areolata</i>
					<i>Systematophora penicillata</i>
					<i>Michrystidium lymensis</i> var. <i>rigidum</i>
					<i>Escharisphaeridia pocockii</i>
					<i>Semistudinium riolutii</i>
					<i>Adnatosphaeridium cailleryi</i>
					<i>Ctenodinium combazii</i>
					<i>Michrystidium stellatum</i>

Figure 4.4. (continued).

CHAPTER V
PALYNOFACIES ANALYSIS,
ORGANIC THERMAL MATURATION
AND SOURCE ROCK EVALUATION

CHAPTER V

PALYNOFACIES ANALYSIS, ORGANIC THERMAL MATURATION AND SOURCE ROCK EVALUATION

Introduction:

The distribution patterns of palynomorphs and other particulate organic matter (POM) could be used for facies recognition and palaeogeographic reconstruction. Palynofacies is a term commonly used to describe the quantitative and qualitative palynological study of the total particulate organic matter assemblage contained in a body of sediment thought to reflect a specific set of environmental conditions, or to be associated with a characteristic range of hydrocarbon-generating potential (Tyson, 1993, 1995). This term was first introduced by Combaz (1964) to describe the total microscopic image of the organic components. Then it became popular however, the definition varied between different authors. Some authors named the organic components “organic matter”, others “palynodebris” but still others “kerogen” (Carvalho, 2001).

The term kerogen is today the most commonly used term to describe the organic components contained in sedimentary rocks (Tyson, 1993). Tyson (1993) used the term kerogen in a purely palynological sense to describe the dispersed particulate organic matter of sedimentary rocks that is insoluble in hydrochloric (HCl) and hydrofluoric (HF) acids.

Palynofacies analysis involves the identification of individual palynomorphs, plant debris and amorphous components, their absolute and relative proportions, size spectra and preservation states. It is an interdisciplinary technique that forms the natural interface between palynology, sedimentology and organic geochemistry (Tyson, 1993).

Present work:

In the present study, kerogen assemblages are categorized into four main groups similar to those identified by Ibrahim *et al.* (1997). These include:

- **Palynomorphs**, refer to all structured HCl and HF resistant organic-walled microfossils.
- **Phytoclasts**, refer to all structured yellow to brown colour dispersed clay- to fine sand-sized particles of plant derived kerogen other than palynomorphs.
- **Opakes**, refer to all structured brownish black to black colour oxidized or carbonized particles of plant derived kerogen.
- **Amorphous organic matter (AOM)**, refers to all structureless dispersed clay- to fine sand- sized particles of plant derived kerogen.

The simple classification mentioned in Tyson (1993, 1995) and Ibrahim *et al.* (1997) for rapid assessment of hydrocarbon potentialities may be used as follows:

1- Kerogen type I (highly oil-prone material): It includes algal material derived from chlorococcale algae, prasinophyte algae, cyanobacteria and some thiobacteria. Resins are the only significant terrestrially derived components belonging to this group.

2- Kerogen type II (oil-prone material): It includes amorphous organic matter, but sporopollenin palynomorphs, cuticle and non-cellular membranous debris are also included.

3- Kerogen type III (gas-prone material): Orange or brown, translucent, phytoclasts or structureless materials. Woody fragments are typical.

4- Kerogen type IV (inert material): Opaque to semi-opaque, black, or very dark brown particles, representing oxidised or carbonized phytoclasts.

Methodology:

Ninety-three kerogen slides were prepared from the Sharib-1X (66 slides) and Ghoroud-1X (27 slides) wells. Each slide was examined using the transmitted light microscopy at X 200 and X 500 magnification in order to make a qualitative as well as a quantitative analysis of the particulate organic matter (POM), determination of the palynofacies and kerogen types, determination of spore colouration and assessment of Thermal Alteration Index (TAI), vitrinite reflectance (Ro %) and organic thermal maturation. Each slide was counted for its (POM) content, in which the first 200 particles were counted in terms of *abundant* (>35 %), *frequent* (16-35 %), *common* (5-15 %) and *rare* (<5 %) (cf. Ibrahim *et al.*, 1997).

Tables 5.2, 5.3. include the semi-quantitative distribution of the various (POM) recorded from the Sharib-1X and Ghoroud-1X wells respectively. Representatives of the studied (POM) are photographed and illustrated in plate 10, figures 8-12 and plate 11.

Palynofacies and kerogen types:

● Sharib-1X well

The studied interval in the Sharib-1X well from 5360-6160 ft can be classified into three major palynofacies types based on the abundance of the (POM) groups. These from youngest to oldest include:

A- Palynofacies 1 (phytoclast and opaque facies):

This facies is the youngest one and is located between 5360-5700 ft from Burg El Arab and Bahariya formations (Figure 5.5). It is characterized by abundant phytoclasts, frequent opaques, common amorphous organic matter (AOM) and common to rare palynomorphs (Figure 5.1).

The phytoclasts consist mainly of pale brown, well to moderately preserved structured terrestrial plant fragments (e.g., tracheids, cuticles, xylem ray tissues and fungal hyphae). Tracheids are the most common phytoclast constituent, mostly in the form of elongate lath-shaped particles lacking any visible pitting; conspicuous perforated bordered