CHAPTER I

INTRODUCTION

Imagine the shores of a lake where a group of people are sitting around a campfire. One man is binding a stone spear-point to a wooden shaft with a leather thong, some are using stone knives to cut up a large sheep, women are tending the cooking fire. You realize that this is an ancient campsite in a place of perhaps 10,000 years old, as reconstructed from the archaeological remains. But the background is blank, the picture is incomplete -no vegetation, no sky. Slowly, the scenery comes into focus. Large aspen trees surround the campsite, while spruce trees clothe the distant mountain slopes, and the sun blazes in a glorious blue sky. This -the landscape behind the people- is the contribution of palynologists. They have carefully examined pollen grains preserved in the lake mud and discovered what plants were growing in this mountain valley and what the climate was like 10,000 years ago.

Palynology has wide applications in the earth and natural sciences. For instance, it can be used to correlate and provide relative ages for layers of rock, mainly in oil exploration (*stratigraphic palynology*), to understand vegetation distributions (*palaeobiogeography*) and climate changes of the past (*palaeoecology*) and to estimate the degree of thermal maturation and the hydrocarbon potentialities of source rocks.

One of the most powerful advantages of palynology as a good palaeontologic tool in age dating, is that it can be used to determine the relative ages of the terrestrially deposited strata beside the marine ones. This practice is very important in subsurface exploration, since there are no fossils within the continental deposits other than the terrestrially derived palynomorphs.

Stratigraphic palynologists have many stratigraphically significant taxa with a marked short duration within the geologic history which enable them to determine more precisely the relative age of any given rock sample.

The presence of certain association of palynomorph species within a rock sample can be used to infer the palaeobiogeographic province in which the area was located during the time of deposition of the parent strata.

During the last decades, palynology has become increasingly involved in tracing the nature of changes in depositional environments in terms of temperature variations, sea level oscillations, water depth and terrigenous influx. The relative occurrence and abundance of the different palynomorph types in addition to the changes in palynofacies types and composition of palynomorph assemblages can be used to interpret accurately the depositional palaeoenvironment of any given rock sample. This practice is so far facilitated by the use of the graphic presentations of the statistical data such as ternary plots and line/symbol graphs to develop an enhanced picture about the environment of deposition.

Palynology has been a powerful tool in oil-exploration. The distribution of the various particulate organic matter including phytoclasts, amorphous organic matter, opaques and palynomorphs within a given rock sequence can be used to estimate the possible source rock horizons of that sequence. This is also facilitated by the use of many types of graphic illustrations of the gathered statistical data from the studied rock layers.

When layers of rock are buried deeply, they are subject to great pressure and heat. This causes alteration, especially colour changes, in palynomorphs in the rock. These colours give palynologists valuable clues about the thermal history of the rocks which are useful for assessing the type and quality of any associated hydrocarbon deposits (coal, oil and gas). Also palynomorph colour changes can be used to estimate approximately some important geochemical parameters such as, the numerical thermal alteration index (TAI) and vitrinite reflectance (Ro %) data.

Using all this information, petroleum geologists can better understand the layering and the structure in the underlying bedrock and work out where would be the best place to drill for oil. Also it can be used to define more precisely the intervals that have exploratory interest and made them easily detectable in logs and seismic data. In this way, exploratory risk and operational costs diminished, because of a better fit between predicted and actual well stratigraphy (Rull, 2002).

Previous work:

The subsurface Jurassic-Cretaceous of northern Egypt was a major target for oil and gas exploration during the last decades and since the discovery of potential hydrocarbon reserves in the Lower Cretaceous (Albian) in 1973 (GUPCO, WD-19-1 well) and in the Jurassic of the Western Desert in 1985 (Khalda Petroleum Company, Salam-3X well), there has been a resurgence of economic interest in these rocks (Ibrahim *et al.*, 1997). As a result, many palynological investigations were carried out by several authors on the subsurface strata of the Egyptian Western Desert. These were initiated in the sixties (e.g., Helal, 1965) followed by other important palynological studies with emphasis on spores and pollen (e.g., Saad & Ghazaly, 1976; Schrank, 1983; Penny, 1986; El-Shamma, 1988, 1994; Abdel Mohsen & Abdel Baset, 1988; El Beialy *et al.*, 1990; Soliman *et al.*, 1991; El Beialy, 1994c; Ibrahim & Abdel-Kireem, 1997; Mahmoud *et al.*, 1999; Schrank & Mahmoud, 2000, 2002; Ibrahim, 2002; Mahmoud & Schrank, 2003). Papers dealing with dinoflagellate cysts and other associated palynomorphs and palynodebris include those of El Sheikh & Aly (1988), Omran *et al.* (1989), Aboul Ela & Mahrous (1990), El Beialy (1994b, d), Ibrahim & Schrank (1996) and El Beialy *et al.* (2002b).

The above investigations led to the recognition of a sedimentary column of several kilometers thick. This includes successions from the Precambrian basement complex to the Recent times that revealed an interesting subsurface geologic history (Mahmoud & Moawad, 2000).

The mid-Cretaceous deposits of the Egyptian Western Desert were described palynologically as early as by Saad (1974) who mentioned the presence of the miospore genera *Galeacorna, Elaterosporites, Balmeisporites* and *Reticulatasporites* (now *Afropollis*), although none of these forms was illustrated (cf. El Beialy, 1993a). This was followed by several publications on mid-Cretaceous palynofloras from beds in the same general area (e.g., Saad, 1978; Sultan, 1978, 1987; Sultan & Aly, 1986; El-Shamma & Arafa, 1988, 1992; El-Shamma & Baioumi, 1992; Aboul Ela & Mahrous, 1992; El Beialy, 1994a, 1995a; Said *et al.*, 1994; Schrank & Ibrahim, 1995; Schrank & Mahmoud, 1998; Mahmoud & Moawad, 1999, 2002). Relevant papers on other parts of Egypt are, for example, those of Abdel Mohsen (1986), Abdel-Kireem *et al.* (1996) and Ibrahim *et al.* (2001, 2002).

In the following paragraphs there will be a brief summary about some of the previous studies carried out on the mid-Cretaceous palynofloras of Egypt in general and the north Western Desert in particular:

Saad (1978) studied 17 ditch samples procured from the Umbarka borehole number 1X, north Western Desert and described 18 genera and 28 species of pteridophytic spores, 11 genera and 21 species of gymnosperm pollen and one genus with three species of angiosperm pollen. He concluded that the plants which have produced the *Elaterosporites* might have favoured brackish water under humid conditions. He also mentioned that the transgression of the sea started in the Aptian age and continued until the beginning of the Albian when a phase of sea regression started and deposition took place under fluvio-marine conditions.

Sultan (1987) described 56 miospore species belonging to 35 genera from the Albian-Cenomanian strata encountered in the Mersa Matruh well no. 1, north Western Desert and correlated them with other coeval palynofloral assemblages in west Africa and South and North America.

El-Shamma & Arafa (1988) reported 23 species belonging to 12 genera of angiosperm pollen from a Lower Cretaceous sequence encountered in three exploratory wells, north Western Desert and compared the reported association with others from different parts of the world.

Omran *et al.* (1990) analyzed qualitatively and quantitatively the palynomorph content of Lower Cretaceous ditch samples from the Fadda-1, Mingar-1X and Sharib-1X boreholes, north Western Desert. They were able to define two miospore palynozones and three dinoflagellate cysts palynozones ranging in age from the Hauterivian to ?Cenomanian.

El-Shamma & Baioumi (1992) analyzed the Lower Cretaceous sediments of three wells in the Salam Oil Field and recognized five palynomorph assemblage zones. These assemblages suggested a regressive phase of the early Cenomanian Sea in the site of deposition.

El Beialy (1993a) investigated five late Albian/early Cenomanian core samples from the Bardawil-1 borehole, north Sinai. A middle to outer shelf palaeoenvironment was suggested on the basis of high numbers of dinoflagellate cysts.

El Beialy (1993b, c) investigated four sidewall core samples and seven cuttings samples collected from the Qarun 2-1 borehole, eastern part of the north Western Desert. He assigned the Kharita Member of the Burg El Arab Formation to ?Aptian to ?early Cenomanian and was deposited in a non-marine palaeoenvironment. He concluded that these sediments are too immature to have any potential source for hydrocarbons.

El Beialy (1994a) introduced the new species *Trilobosporites laevigatus* from the middle/late Albian rocks encountered in the Badr El Dein (Bed 1-1) borehole, north Western Desert.

El Sheikh & Aly (1994) identified eight palynomorph zones together with one planktonic and one benthonic foraminiferal zones from the subsurface Jurassic-Lower Cretaceous sediments of north Sinai and correlated them in other basins.

Schrank & Ibrahim (1995) subdivided the Aptian-Maastrichtian succession of the Kahraman-1 well (KRM-1), northwestern Egypt into nine informal pollen-spore and nine dinoflagellate cyst zones.

Ibrahim *et al.* (1995) summarized the Cretaceous biostratigraphy and palaeogeography of north Egypt and north-east Libya and found that there is an intimate resemblance between the respective counterparts of the palynological and the foraminiferal assemblages in both areas.

Ibrahim (1996) studied the Aptian-Turonian palynology of the Ghazalat-1 well (GTX-1), Qattara Depression, north Western Desert and erected five new pollen species belonging to the genera *Droseridites, Foveomorphomonocolpites, Retimonocolpites* and *Dichastopollenites*. He also provided very important information on the palynostratigraphy, palaeoenvironment, palynofacies and hydrocarbon potentiality of the studied sequence.

Aboul Ela *et al.* (1996) dealt with the stratigraphic distribution of miospores and organic-walled microplankton, mainly in the Bahariya Formation, encountered in the Salam-5 and Salam-8 wells drilled in the north Western Desert. They established three palynozones ranging in age from the late Albian to early Cenomanian and indicated that the Bahariya Formation was deposited in warm, shallow, near shore waters under tropical sub-humid climatic conditions.

Schrank & Mahmoud (1998) described the new species *Retimonocolpites variplicatus* from 15 core samples in ten boreholes penetrating the Six Hills and Maghrabi formations in the Dakhla Oasis area, central Western Desert. They also discussed the palynostratigraphy and palaeoecological implications of these rocks.

Mahmoud & Moawad (1999) recovered some mid-Cretaceous palynomorphs from the Ghroud-1X borehole constituting two informal palynomorph zones of Albian and early Cenomanian age. Shallow (restricted) marine palaeoenvironment is inferred for the Albian deposits, while normal open (shallow) marine conditions are believed to have occurred during deposition of the early Cenomanian sequence.

Mahmoud & Moawad (2002) suggested three informal pollen-spore zones ranging in age from Aptian to early Cenomanian from the Burg El Arab, Bahariya and Abu Roash formations encountered in the Sanhur-1X borehole, north Western Desert. They mentioned that the depositional environment was fluctuating between marginal to open marine (inner shelf) with minor terrestrial episodes during the Aptian time.

El Beialy *et al.* (2005) investigated the subsurface Upper Jurassic-Lower Cretaceous deposits in the Sharib-1X borehole, north Western Desert with emphasis on the age dating, palaeoenvironmental deductions and organic thermal maturity.