8. Conclusions

The study of calcareous nannofossils, planktonic and benthonic foraminifera from the Late Cretaceous-Early Tertiary succession in the Sinn El Kaddab-Wadi Abu Ghurra stretch, southwestern Nile Valley, Egypt allows the following conclusion.

1. A great hiatus exists between the Maastrichtian and Paleocene corresponding in time to the duration of the *A. mayaroensis*, *G. cretacea* (P0), *P. eugubina* (P alpha) and *Pa. Pseudobulloides* (P1a,b) Zones. The same hiatus can also be matched by the absence of the calcareous nannofossil Zones *M. murus* (CC25c), *M. prinsi* (CC26), *M. inversus* (NP1), *C. tenius* (NP2). This supports the view that the sedimentation in central Egypt began after the sea-level rise in Biochron P1c (Speijer & Schmitz, 1998). Another minor hiatus includes the *Pr. uncinata* (P2), the upper part of the *M. angulata* (P3a) and the *I. pusilla* (P3b) Zones. This hiatus includes the calcareous nannofossil Zones of *E. macellus* (NP4) and *F. tympaniformis* (NP5). A minor hiatus was recorded in the Early Eocene due to the absence of the lower part of *M. edgari* (P6a) Zone as well as the lower part of the *T. contortus* (NP10) Zone.

2. The paleodepth of the Late Cretaceous-Early Eocene succession ranges from lagoonal in the Late Campanian and Maastrichtian to middle-outer neritic (50-200 m) in the Paleocene-Early Eocene, with the maximum paleodepth during the sea-level maximum (Biochron P4).

3. The Maastrichtian to Early Eocene sedimentary sequence may be subdivided into three almost complete transgressive/regressive cycles. The transgressive cycles (early Late Maastrichtian, late Early Paleocene, Late Paleocene) reflect a continuously increasing marine influence upon sedimentation, coming from the Tethyan Sea in the north. The regressive cycles are (Early Maastrichtian, Late Maastrichtian to Early Paleocene, latest Paleocene to Early Eocene). After the climax of the transgression during late Paleocene time, which caused open marine deposits (Garra Formation), a shallow-shelf facies was developed caused by the shallowing of the sea level in Early Eocene time.

4. The presence of *Ammoastuta megacribrostomoides* in the mixohaline benthonic foraminiferal assemblages which were recorded in the Late Maastrichtian and Early Paleocene successions is regarded as a facies-index fossil for brackish littoral conditions in climates with high rainfall and high runoff (Luger, 1988a).

5. The Paleocene/Eocene boundary lies in the topmost part of the Garra Formation in all studied sections. The Paleocene Eocene Thermal Maximum event (PETM) is marked by the most important event in Cenozoic history. This event is best epitomized in the study area by the conspicuous generic and family turnover in the calcareous nannoplankton fossils, the major turnover in the diversity and abundance of the planktonic foraminifera and the most severe extinction of calcareous benthonic foraminifera.

A- *Tribrachiatus bramlettei*, *Transversopoints pulcher* begin to appear immediately above the BEE level while *F. tympaniformis* has it’s last occurrence in the same level. The genus
Conclusion

*Fasciculithus* decreased in abundance and diversity above the benthonic extinction event (=BEE) level until extinct in the basal part of (NP10). The representatives of the family Prinsiaceae decreased considerably relative to *Coccolithus pelagicus* across the P/E boundary. The “*C. pelagicus* acme” can be used to recognize the P/E boundary interval in sections where markers are very rare or absent (Perch-Nielsen, et al., 1998).

B- The planktonic turnover involves the FO of *Globanomalina luxorensis* together with the influx of warm water taxa (*Morozovella* and *Acarinina*), a decrease in cooler water taxa (*Subbotina*) and sudden short-term increase in low oxygen tolerant taxa (*Chiloguembelina*). The beginning of an increase of the warm water acarininds just above the BEE includes *A. sibaiyaensis* and *A. hispidicidaris*. On the other hand, the following species have their LO just below the BEE level *Subbotina triloculinoides*, *S. triangularis*, *Igorina albeari*, *Morozovella occlusa*, *M. angulata*, *M. conicotruncata* and *M. parva*.

C- The benthonic foraminiferal turnover involves the disappearance of several taxa, amongst them taxa that became globally extinct (*Angulogavelinella avnimelechi* and *Neoflabellina jarvisi*). This observation provides strong evidence that the BEE marking the P/E boundary cannot be considered as a deep see phenomenon only. The term deep-see extinction event is thus incorrect, because it suggests that shallow benthonic ecosystems were unaffected during the P/E transition. The present study-as well as other studies in neritic environments-suggest that the neritic benthonic ecosystems were at the same time severely perturbed (e.g. Gibson et al., 1993; Speijer et al., 1996a, b). However, the relative and absolute numbers of extinctions clearly decrease towards shallower sites at the southern Tethyan margin. The extinction percentage is only 6% in the Sinn EL Kaddab section, In the Kurkur Naqb Dungul and the Wadi Abu Sayal sections, the extinction percentages is 13% and in the Wadi Abu Ghurra section the extinction percentages is 28%. Data of other neritic sites in Egypt show the same trend of extinction. The middle-outer neritic Gabal Aweina (Nile Valley, Egypt) sequence indicates an extinction percentage of 25% (Speijer et al., 1996a). A slightly lower extinction percentage of 20% was recorded (Speijer et al., 1996b) for the middle neritic benthonic succession at Gabal Duwi (Red Sea coast, Egypt).

D- In Tethyan outer neritic sites the disappearance of *Angulogavelinella avnimelechi* may be a better biostratigraphic marker for the level of the benthonic extinction event (BEE).

6- Combined shallowing and eutrophication led to the appearance of very characteristic Late Paleocene-Early Eocene assemblages in the study area, that have also been recorded at other sites on the southern Tethys margin. It appears that eutrophic, oxygen-deficient mud shelves developed along the southern Tethys during the Late Paleocene (Kouwenhoven et al., 1997).

7- Dysoxic conditions and maximum food levels prevailed after the BEE, as indicated by assemblages dominated by bulminides (15%), *Lenticulina* spp.(90%) and *Stainforthia* spp. (90%). This maximum in trophic resources and minimum ventilation resulting from enhanced surface productivity.