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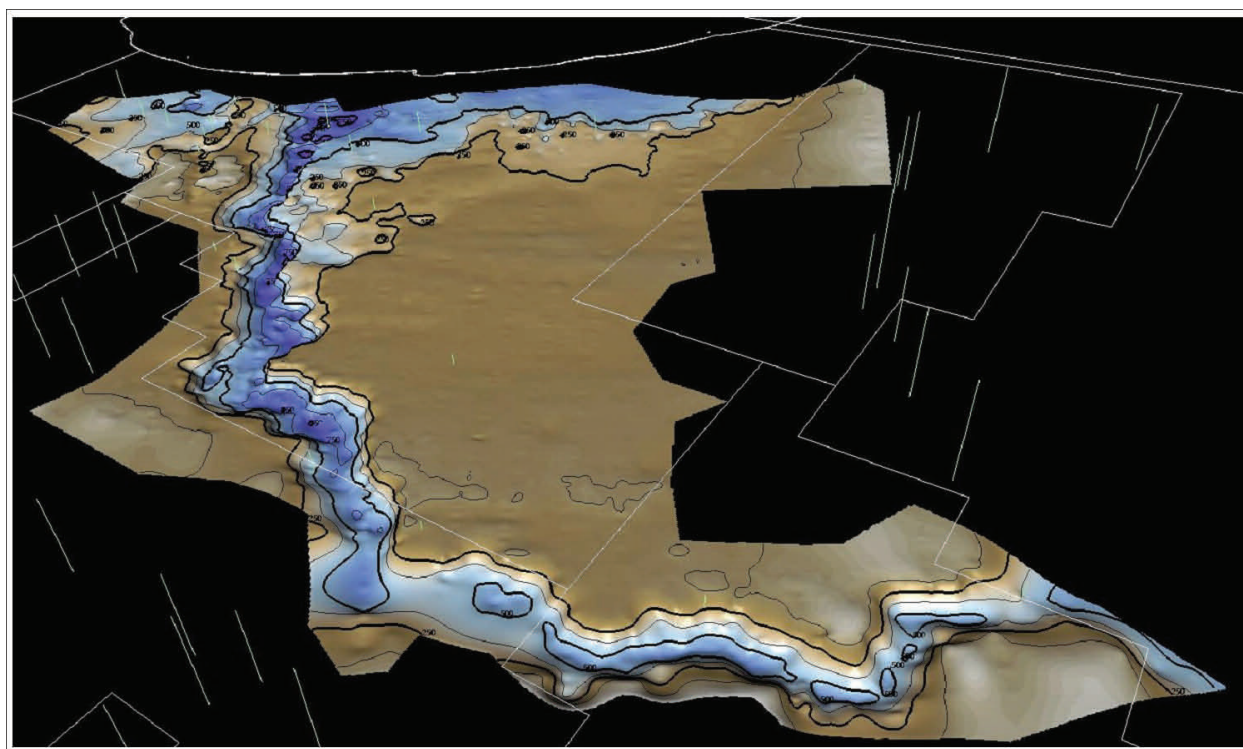


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## *Circum-Mediterranean Geology and Biotic Evolution During the Neogene Period: The Perspective from Libya*

Edited by N.T. Boaz, A. El-Arnauti, P. Pavlakis, and M.J. Salem



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# A Brief History of As Sahabi Research and Collections

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## ABSTRACT

Organised palaeontological fieldwork in the area of sedimentary outcrops surrounding the historic fort of Qasr as Sahabi has taken place during three periods of time: the mid to late 1930's by Italian expeditions directed by Carlo Petrocchi, the late 1970's to early 1980's by the International Sahabi Research Project (ISRP), and current work under the auspices of the international East Libya Neogene Research Project (ELNRP). As Sahabi yielded to Petrocchi seven species new to science. Five species new to science have been discovered at As Sahabi since 1979. Initial fossil discoveries and most of the original 62 Petrocchi localities were in the vicinity of the As Sahabi fort. These localities in upper Members U and V of the Sahabi Formation have now been re-located, accurately positioned, and re-surveyed by the ELNRP. Original ISRP fossil localities were mainly located along the better exposed sediments to the west of the Sebkhat al Qunayyin, east and north of the As Sahabi fort, primarily in lower Member U of the Sahabi Formation. These spatial and stratigraphic differences between Petrocchi and ISRP localities account for observed differences in the two faunal assemblages. Ongoing geological research is aimed at elucidating the temporal and sedimentary facies variations that explain the differences in taxonomic make-up and evolutionary stages within the As Sahabi fauna. The historic initiation of drilled boreholes to elucidate the subsurface stratigraphy and the successful application of absolute geochronology are major steps in the research program of the ELNRP. Collections of fossils and geological samples from As Sahabi are housed at the Earth Sciences Museum of the University of Garyounis (ISRP and ELNRP) and at the Libyan National Museum (early Italian collections). Ongoing research at As Sahabi and Jabal Zaltan by the ELNRP will increase palaeontological collections and heighten the need for specialist training, making museum and university collaborations essential.

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Palaeontological investigations near the fort of Qasr As Sahabi were begun in the late 1920's or early 1930's by Ardito Desio and fully developed by Carlo Petrocchi and colleagues between 1932 and 1937 (see Rook's following article in this volume). Petrocchi was the first director of the Libyan Museum of Natural History, founded within the confines of the historic Saray al-Hamra fort in Tripoli harbor. Today the new National Museum of Libya occupies the entire site, and natural history is represented in the museum's public exhibits. Fossil specimens excavated from As Sahabi, particularly the skull and partial skeleton of *Stegotetabelodon syrticus*, formed a major part of the old natural history museum's exhibits (Figure 1). As Sahabi fossils discovered by Petrocchi are still on display today. They include a skeleton of a still unstudied fossil whale (Figure 1), a mandible of *Stegotetabelodon*, and a complete skull and jaw of the unique Sahabi crocodile, *Crocodylus checchiai* (see article by Delfino, this volume). Table 1 lists the species new to science and generally recognised by

specialists discovered by the expeditions led by Carlo Petrocchi at As Sahabi.

Table 1. New Species of Fossil Vertebrates  
Discovered from As Sahabi 1934-1939

|                                                      |
|------------------------------------------------------|
| <i>Anancus petrocchii</i> Coppens 1965               |
| <i>Crocodylus checchiai</i> Maccagno 1947            |
| " <i>Leptobos</i> " <i>cyrenaicus</i> Petrocchi 1956 |
| <i>Libycosaurus petrocchii</i> Bonarelli 1947        |
| <i>Miotragoceros cyrenaicus</i> Thomas 1979          |
| <i>Nyanzachoerus syrticus</i> Leonardi 1954          |
| <i>Stegotetabelodon syrticus</i> Petrocchi 1941      |

The Second World War ended all palaeontological field research at As Sahabi for some four decades. In 1974 Noel Boaz wrote a letter to the Faculty of Science in Tripoli proposing renewed research at As Sahabi and was invited to come to Libya the following year. This visit culminated in

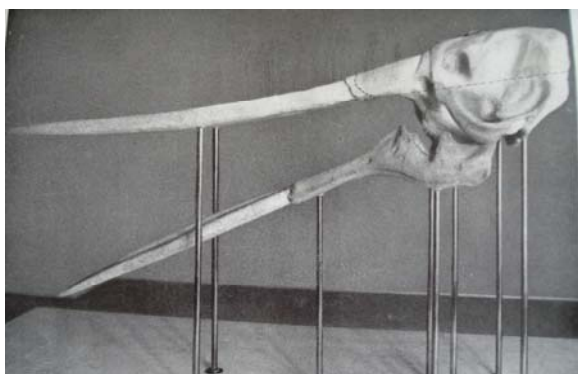


Figure 1. Left: The type specimen of *Stegotetabelodon syrticus* on display in the old Libyan Museum of Natural History, Tripoli (Petrocchi, 1951); Right: The fossil cetacean excavated by Petrocchi in 1934, with a half-scale reproduction above, currently on display in the National Museum of Libya, Tripoli.

the formation of the International Sahabi Research Project (ISRP), based at the University of Garyounis, Benghazi, and headed by Boaz, Ali El-Arnauti, and Abdel Wahid Gaziry. The project worked in the field between 1977 and 1981. The first report on the renewed research was Boaz *et al.* (1979) and the first geological reports were de Heinzelin *et al.* (1980) and El-Arnauti and de Heinzelin (1985). The ISRP subsequently produced a number of scientific papers and two volumes – an earlier special issue of the *Garyounis Scientific Bulletin* (Boaz *et al.*, 1982) and a multi-authored edited monograph *Neogene Paleontology and Geology of Sahabi* (Boaz *et al.*, 1987). Table 2 lists the species new to science discovered and named at As Sahabi since 1979.

Table 2. New Species of Fossil

|                                                             |
|-------------------------------------------------------------|
| <i>Abudhabia yardangi</i> Munthe 1987                       |
| <i>Amebelodon cyrenaicus</i> Gaziry 1987                    |
| <i>Cercopithecini sp. nov.</i> Benefit <i>et al.</i> , 2008 |
| <i>Dytikodorcas libycus</i> (Lehmann and Thomas) 1987       |
| <i>Hexaprotodon sahabiensis</i> Gaziry 1987                 |

An international trade embargo and travel restrictions to Libya prevented field research from taking place for many years. In spite of this embargo and with the logistic efforts of the University of Garyounis, National Oil Corporation (NOC), the Arabian Gulf Oil Company (AGOCO), Sirt Oil Company, and the Libyan National Foundation of Research

(NFR), an international conference on the “Biotic and Climatic Effects of the Messinian Event in the Circum-Mediterranean” was organised by Ali El-Arnauti and the staff members of the Department of Earth Sciences in Benghazi between January 14-18, 1995. The conference was held in association with the Regional Committee of the Mediterranean Neogene Stratigraphy, Montpellier (RCMNS), the International Institute for Human Evolutionary Research (IIHER), and the Research Centre, University of Garyounis, Benghazi.

At the Benghazi symposium in 1995 the surviving principals of the ISRP agreed to renew investigations at As Sahabi and initiate research at Jabal Zaltan. Research was organised by Ali El-Arnauti at Jabal Zaltan in 1997 and at As Sahabi in 1998 by Europe-based teams (and members of the Department of Earth Sciences, University of Garyounis). The late Remmert Daams of the University of Madrid led a team that undertook micromammal wet-sieving at Jabal Zaltan. The results of this important work (Wessels *et al.*, 2003), as well as from an independent field season in 1983 co-organized with Abdel Wahid Gaziry, are reported here by Wilma Willems and colleagues (this volume). Jordi Agustí, then of the Crusafont Institute of Paleontology, Sabadell and now of the Institute of Human Paleoecology, Tarragona, led a team to As Sahabi for wet-sieving for micromammals, and he reports those important results in this volume.

In 2004 during the international symposium on the “Geology of East Libya” held in Benghazi, a number of papers dealing with As Sahabi research and related areas contributed as a group an important



Figure 2. Excursion to As Sahabi during the 2004 international symposium on the “Geology of East Libya.” Above, participants at the ruins of Qasr As Sahabi; below, in exposures of the Sahabi Formation west of the Sebkhah al Qunayyin

perspective to the proceedings (Salem *et al.*, 2008). An excursion led by Ali El-Arnauti to the As Sahabi area followed this symposium (Figure 2) and a book entitled “Short Notes and Guidebook on the Geology of Qasr As Sahabi Area” was prepared by Ali El-Arnauti and Ali El-Sogher (2004)

Using the opportunity afforded by this gathering, it was decided to formally organise the As Sahabi and Jabal Zaltan research into the East Libya Neogene

Research Project (ELNRP). With normalisation of international relations in 2005, renewed research was funded by the U.S. National Science Foundation and the University of Garyounis, and an initial field season was undertaken to As Sahabi in 2006 led by Noel Boaz, International Director of the ELNRP, and Ahmed Muftah and Muftah Shawaihdi, Libyan Co-Directors of the ELNRP (Figure 3).

Following up on this beginning a palaeontological field team led by Paris



Figure 3. ELNRP field team at As Sahabi, September 19, 2006. The field teams in 2006 and 2007 carried the flag of the Explorers Club, New York. L-R: Fathi Salloum, Ahmed Muftah, Mohammed Al-Faitouri, Noel Boaz, Muftah Shawaidhi. Kneeling; Driver.

palaeontological field team led by Paris Pavlakakis, and geological team led by Ahmed Muftah and Muftah Shawaidhi, worked at As Sahabi during February and March, 2007 (Figure 4). Significant new vertebrate fossils were recovered during this and the subsequent field season in April, 2007, and most of these specimens have been included in the discussions of their relevant taxonomic groups in this



Figure 4. ELNRP Field Crew, February-March, 2007

volume.

In April, 2007 systematic drilling in the Sahabi Formation, under the direction of Noel Boaz, Ahmed Muftah, and Muftah Shawaidhi, for the purpose of ascertaining lateral facies variation to the west of the main exposures was undertaken (Figure 5), along with limited palaeontological survey. Ahmed Muftah and colleagues report on the important stratigraphic conclusions of this research in this volume. Muftah's analysis has convincingly refined the age of Formation M to the Late Miocene. The



Figure 5. Drilling Boreholes 1 and 2 at As Sahabi, April, 2007

absence of a thick gypsiferous "Formation P" in the west, at the site of the boreholes, is evidence for a more localised extent of this deposit. This is one of the first instances in which terrestrial boreholes have been drilled to elucidate stratigraphy in vertebrate palaeontological research.

In June, 2007 a short geological field season was carried out by Claus Beyer of CB-Magneto, Stavanger, Norway, in association with Ahmed Muftah and Muftah Shawaidhi. Initial palaeomagnetic results from the Sahabi Formation are reported by Beyer in this volume. Beyer discovered the long-sought-for occurrence of potassium-rich glauconites at As Sahabi,

which have yielded the first potassium-argon dates (7.5 to 7.7 ma from Formation M). The age of the bulk of the palaeontologically important Sahabi Formation collections was revised by Boaz *et al.* (2008) to the Late Miocene, but unambiguous geological support for this conclusion is still pending. More data are needed. Further geochronological work on a putative ash level in U-1, as well as potassium-rich glauconites, is needed in order to bring radiometric dates to bear on this problem.

Two vertebrate palaeontological studies in the current volume bring up the issue of the time interval covered by the Sahabi Formation faunal collections. From surface outcrop stratigraphy of the localities of discovery, levels from which fossil vertebrates derive are assessed to be primarily Member U (units U-1 and U-2), but Members T and V, both above and below Member U, are considered also to have yielded fossils (see Muftah *et al.*, this volume). Sanders' paper on previously undescribed As Sahabi proboscideans in the Tripoli museum collected in the 1930's notes a significant taxonomic difference between these specimens, all anancines, and the assemblage from As Sahabi originally reported by Gaziry in the 1980's. The former specimens were all collected in localities in the western area of exposure of the Sahabi Formation, from sediments of upper Member U or Member V, whereas virtually all of the fossils collected since the 1970's derive primarily from unit U-1 exposed in eastern localities near the Sebhkat al Qunayyin. Gentry (this volume) notes that a new partial skull of the bovid

*Miotragoceros cyrenaicus* from U-1 has more primitive attributes than the type skull of this species described from western localities at As Sahabi by Petrocchi in 1952. H.B.S. Cooke in the 1980's made similar observations based on the suid fauna from As Sahabi. All these studies suggest a time interval of perhaps 1 ma or more between Members U and V of the Sahabi Formation, but a definitive conclusion on this point must await further detailed stratigraphic and geochronological work.

#### IDENTIFICATION AND RECORDING OF LOCALITIES

All fossil localities established by the ISRP at As Sahabi were recorded on aerial photographs and mapped stratigraphically (see de Heinzelin and El-Arnauti, 1987). The same system of naming and recording localities has been followed by the ELNRP. As part of renewed fieldwork all P localities were relocated and recorded by GPS positioning. In 2007 all 62 Petrocchi localities (Figure 6) were precisely re-located, surveyed, and recorded by GPS position.

#### CURRENT STATUS OF THE COLLECTIONS

Collections made at As Sahabi by Italian teams under the direction of Carlo Petrocchi in the 1930's (see Rook, this volume) are in several venues in Italy and in the National Museum of Libya in Tripoli. Most or all of the specimens in Italy have been described. The As Sahabi specimens in Tripoli include the type specimen of

*Stegotetrabelodon syrticus* (Figure 7) and a number of previously undescribed proboscideans (Sanders, this volume), hippopotamids (Pavlakis, this volume), and anthracotheres (Pavlakis and Boaz, this volume).

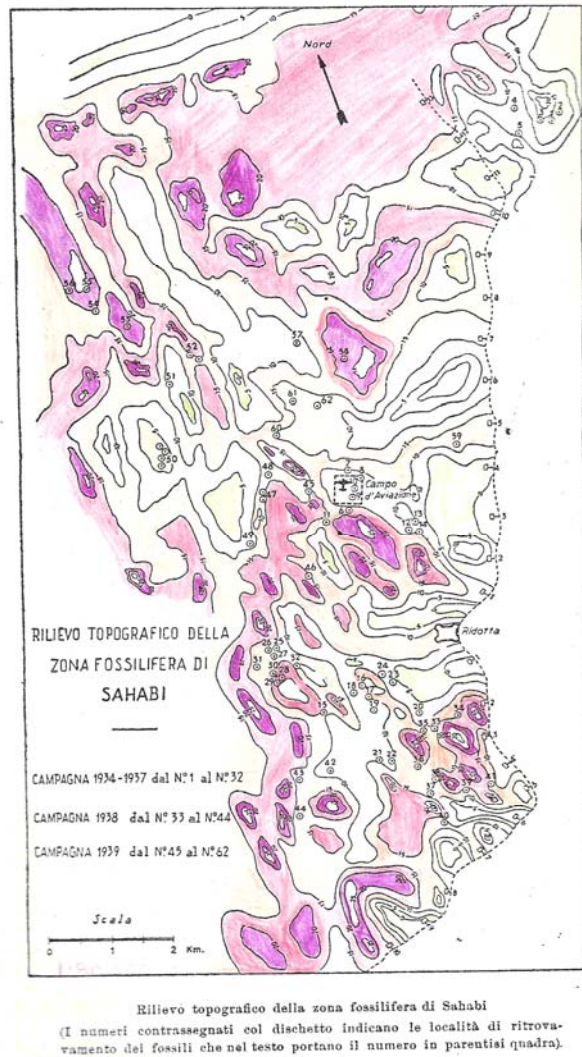


Figure 6. As Sahabi fossil localities (Petrocchi, 1951)

By agreement, all fossil collections from As Sahabi and Jabal Zaltan that have been collected by the teams of the ELNRP and its predecessor, the International Sahabi Research Project, will be permanently housed at the Earth Sciences Museum of the University of Garyounis, Benghazi (Figure 8). As newly discovered specimens are studied and described in the various laboratories of ELNRP scientists around the world, their whereabouts are recorded in the digitised specimen catalogue. These databases are maintained at the International Institute for Human Evolutionary Research in Oregon, U.S.A., and at the University of Garyounis, Benghazi, Libya.

#### CONTINUING RESEARCH AND MUSEOLOGICAL DEVELOPMENT

As impressive as are the past palaeontological discoveries at As Sahabi, the future will see an increase in numbers and quality of specimens. Increasing the collection is necessitated by a less-than-full knowledge of the morphology of taxa already documented and ignorance of the full diversity of the past fauna. All surface outcrops and all established “P” fossil localities accessible in the As Sahabi area have now been intensively surveyed at least twice since the inception of research in 2006. All early fossil localities established by the Petrocchi teams have also been surveyed at least twice. The rate of recovery of significant discoveries from surface survey alone has slowed because the rate of



Figure 7. Left: Initial preparation work on the fossil proboscidean fossils from As Sahabi collected by the Petrocchi expeditions in the 1930's and now housed in the Libyan National Museum, Tripoli. The type specimen of *Stegotetralodon syrticus* Petrocchi 1941, in dire need of restoration, is in the background. Right: A 1996 Libyan postage stamp commemorating the famous discovery.



Figure 8. Left: The main gallery of the Earth Science Museum at the University of Garyounis. New exhibit cases and cabinets have fossils and geological specimens from As Sahabi on display with temporary labelling, but permanent exhibits have yet to be developed. Right: The preparation laboratory of the Earth Science Museum of the University of Garyounis in September, 2006, illustrating the many unpacked boxes of fossils from As Sahabi relocated from the former ISRP lab at the Garyounis Research Centre. These fossils have now been placed in museum trays and stored in new collection storage cabinets in the museum. Specimens are in need of professional preparation, casting, and curation.

aeolian erosion at As Sahabi is not rapid enough to uncover new fossiliferous exposures from one field season to the next. “Sweeping” of the Recent overlying coarse sand in potentially fossiliferous areas has not yielded good results at As Sahabi, perhaps because the winds are not as strong here as at other North African fossil sites, such as the Fayum, Egypt, and Toros Menalla, Chad, where this technique has been successful. Excavation for macrofaunal remains in the easily excavated unconsolidated sands of Member U of the Sahabi Formation, however, holds great promise and there are dozens of square km of accessible and known fossiliferous sediments. Wet-sieving for micromammal remains at productive localities will also intensify at As Sahabi in the coming years of work. Palaeontological surface survey, wet-sieving, and excavation in the extensive fossiliferous exposures of Jabal Zaltan will add further to the numbers of specimens coming into the collections.

As fieldwork continues, the need for the development of museum resources to adequately store collections and make them

accessible for comparative study by researchers will increase. Concomitant with increasing collections will be the demand for public dissemination of news and interpretations of the discoveries. Both are central parts of the mission of museums. The ELNRP’s agreement with Shell Libya (Figure 9) includes these important components of museological development for Libya.

#### UNIVERSITY AND ELNRP COLLABORATION

As research proceeds, many specialty studies within the broad disciplines of geology and palaeobiology will need to be added to the repertoire of the East Libya Neogene Research Project. The need to more intensively investigate the age and dating of the sediments will bring in specialists in geochronology. The need to understand and better model ancient sedimentary environments will require new specialists in sedimentology and geochemistry. Gaining a better knowledge of past floras, through both pollen and fossil



Figure 9. An agreement with Shell Exploration and Production Libya (General Manager Marc Gerrits, in center) will allow the ELNRP (Noel Boaz, International Director, at left) and Libyan museums (Giuma Anag, Chairman, Department of Archaeology, National Museum of Libya, at right) to work together in developing museum collections and exhibits.

wood, is key to a better grasp of Late Neogene palaeoenvironments. As more and more previously unknown vertebrate and invertebrate taxa are discovered, more specialists on these groups will come into the project.

No single university or research institute is large or diverse enough to encompass all the requisite specialties or training opportunities now needed in a large interdisciplinary research project like the ELNRP. Consequently, collaborative arrangements with universities and other research organisations are essential. These agreements can serve to train graduate students, provide valuable opportunities for faculty research, and advance universities'

research missions. One such research and training agreement that grew out of respective faculty members' involvement in the ELNRP was signed in Benghazi on March 5, 2008 between the University of Garyounis and the University of Athens (Figure 10). We look forward to the further development of such important and mutually beneficial international inter-university collaborations. It is only through wide academic and institutional networks that we will be able to adequately address the daunting but exciting research and training challenges posed by the wealth of discovery now being presented to us from the Neogene of Libya.



Figure 10. Signing ceremony between University of Garyounis and University of Athens for collaborative research and academic programs, Benghazi, March, 2008. Left to right: A. Shukri, I. Velissaropoulou, University of Athens Vice-Rector I.K. Karakostas, M. El-Mansoury, University of Garyounis Vice-President M. El-Awami, H. El-Braasi, N. Boaz, E. Pavlakis, P. Pavlakis, A. El-Hawat, A. El-Arnauti, B. Mohammed, F. Salloum.

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