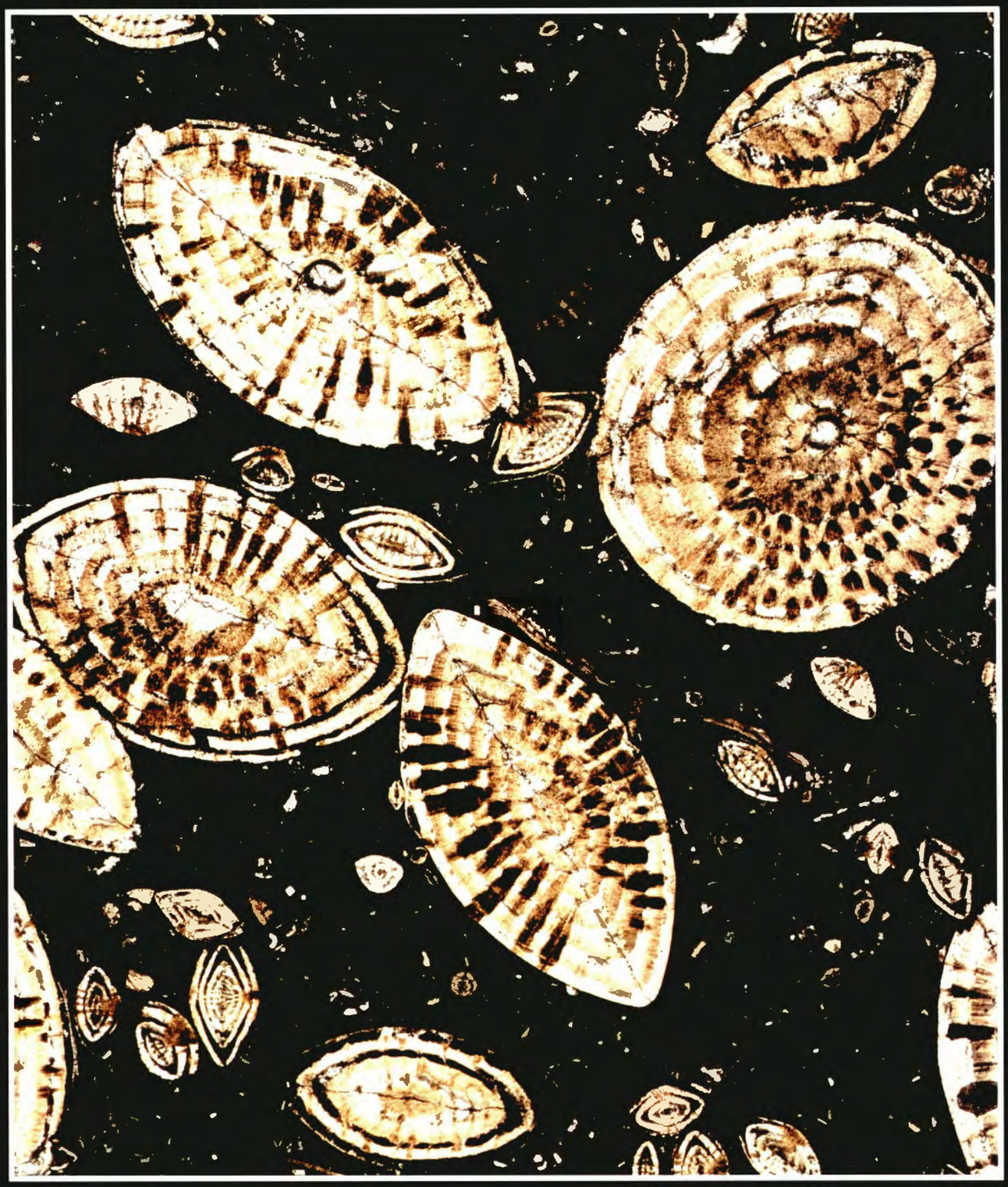
SOUTHERN TETHYS BIOFACIES



Agip

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Photos of Agip Archives

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This Atlas illustrates the most significant biofacies found in the Mediterranean, the Middle East and in Eastern Africa by AGIP during about 50 years of activity.
It represents AGIP's contribution to the on-going study of micropaleontology as applied to petroleum exploration.
Rather than being simply an update and extension of "Microfacies Italiane" (1959), this edition features completely revised material, since it was edited according to the latest stratigraphic criteria which take into account fossil paleoecology.
This undertaking is part of a long-standing AGIP tradition in developing and sharing applied knowledge in the various scientific disciplines.
"Microfacies Italiane", published by AGIP Mineraria in 1959, was highly praised both for its technical and didactic content, and like the previous Atlas of "Foraminiferi Padani" (1957) all the available copies were rapidly exhausted.
Consequently in order to satisfy the continuous demand from outside and from within our company, and to keep pace with the growth of knowledge in biostratigraphy as applied to hydrocarbon exploration, we decided to produce a completely new "Iconographic Atlas". This volume is intended for all those who wish to adopt a practical approach to the study of biofacies by means of thin sections.

The Atlas illustrates some of the most significant biofacies from the Paleozoic through the Cenozoic, selected from a far greater area than our national territory.
In addition to our data, from wells and surface sections, this work has taken into account a wide variety of comprehensive and detailed studies (biozonations, correlations, paleoenvironmental and paleogeographic reconstructions etc.) produced in recent years.
Most of the material used was selected from thousands of surface and subsurface samples of sedimentary rock collected by AGIP in the Mediterranean area, Middle East and East Africa (the "Southern Tethys Domain").

Our iconographic collection has been enriched and completed by the addition of several particularly significant biofacies provided by the Earth Sciences Departments of the Universities of Milan and Perugia and the Institute of Paleontology of the University of Naples.
In setting out to produce this volume, our aim was to give our experts and all interested biofacies scholars a practical tool for improved stratigraphic and paleoenvironmental studies.
This Atlas, promoted by our Prof. Luigi Mattavelli, was compiled in AGIP's Stratigraphic Department by Drs. Dario Sartorio and Sandro Venturini under the supervision of Drs. Achille Balduzzi and Emilio Bellini, and with the cooperation of all the stratigraphers in the unit.

We wish to express our deep appreciation to Professors Bianca Maria Cita, Camilla Pirini, Gloria Ciarapica and Filippo Barattolo who provided us with invaluable material, as well as for their suggestions, and to Professors Isabella Premoli Silva and Piero De Castro who reviewed the manuscript.

Giuseppe Muscarella
Chairman

SUMMARY

PALEONTOLOGICAL MATERIAL AND THE SIGNIFICANCE OF THE SOUTHERN TETHYS DOMAIN.

The paleontological material was chosen on the basis of our working requirements, highlighting those biofacies useful to the exploration stratigraphy.
Therefore uncommon assemblages and rare taxa, even if of a certain significance to the specialists, were deliberately ignored. The availability of paleontological material from AGIP archive has also influenced this choice. This justifies the special attention given to the Southern Tethys Domain which is paleontologically characterized by biofacies common to our peninsula, to many Mediterranean countries, to the Middle East and Eastern Africa, with a large variety of taxa from Paleozoic to Cenozoic.
The Southern Tethys Domain (Fig. 1 and 2), started developing in the

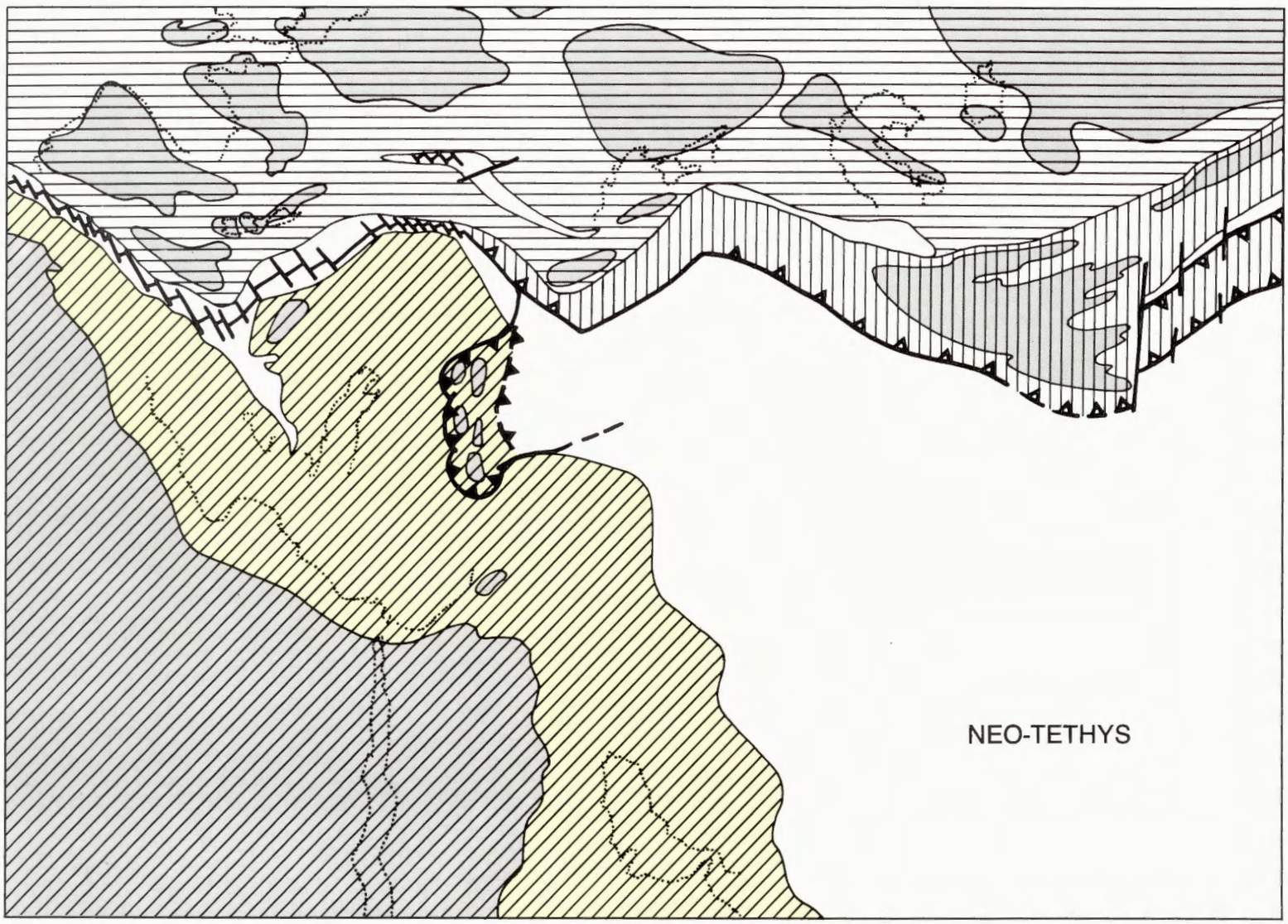
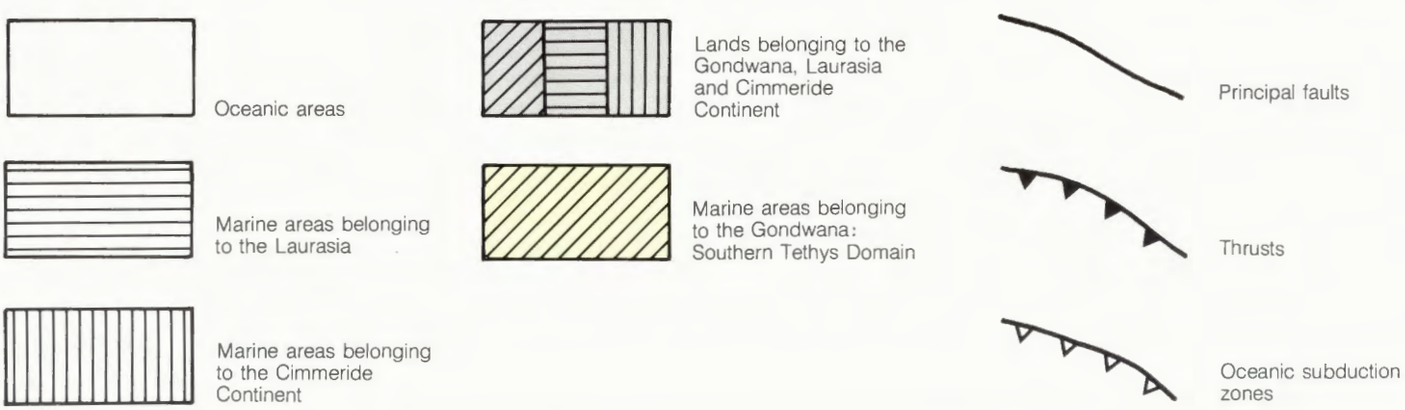


Fig. 1. **LATE JURASSIC - EARLY CRETACEOUS**: Southern Tethys Domain. Modified from DERCOURT *et alii* 1985 and ŞENGÖR 1984.



Early Jurassic (South neo-Tethyan margin) as a consequence of the Central Atlantic rifting. The Southern Tethys Domain is characterized by macro and micropaleontological assemblages which are often different from those found in the northern side of the Tethys. Paleontological material from Central Europe was used only for the Paleozoic. This choice is justified by considering that before the Jurassic, the Central Atlantic and the areas at present around the Western Mediterranean almost certainly belonged to a single continental landmass.
Although this Atlas refers only to the Southern Tethys Domain, it contains the main microfossil groups which played an important role in the geological history of the Earth from Paleozoic to Cenozoic.

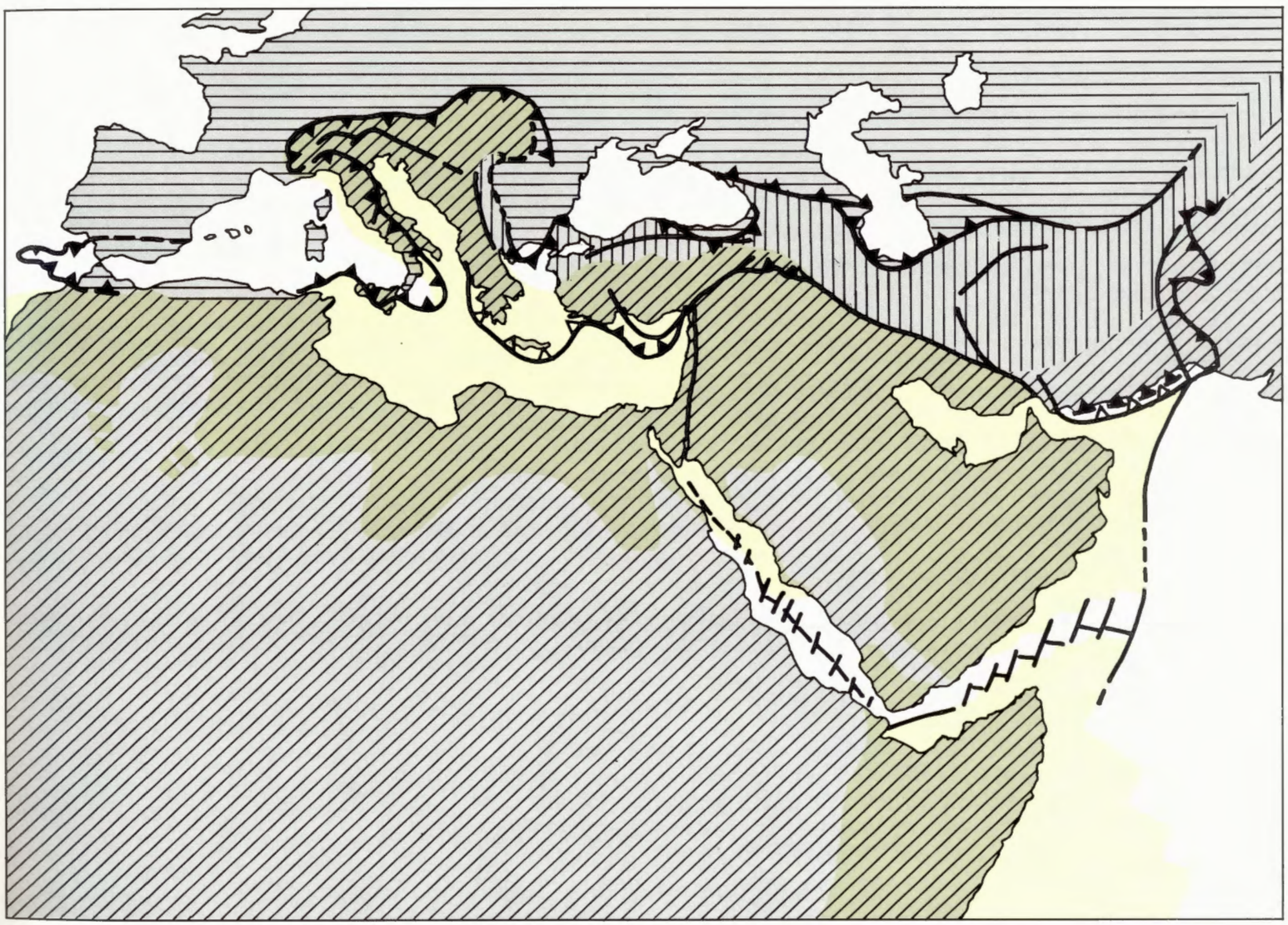
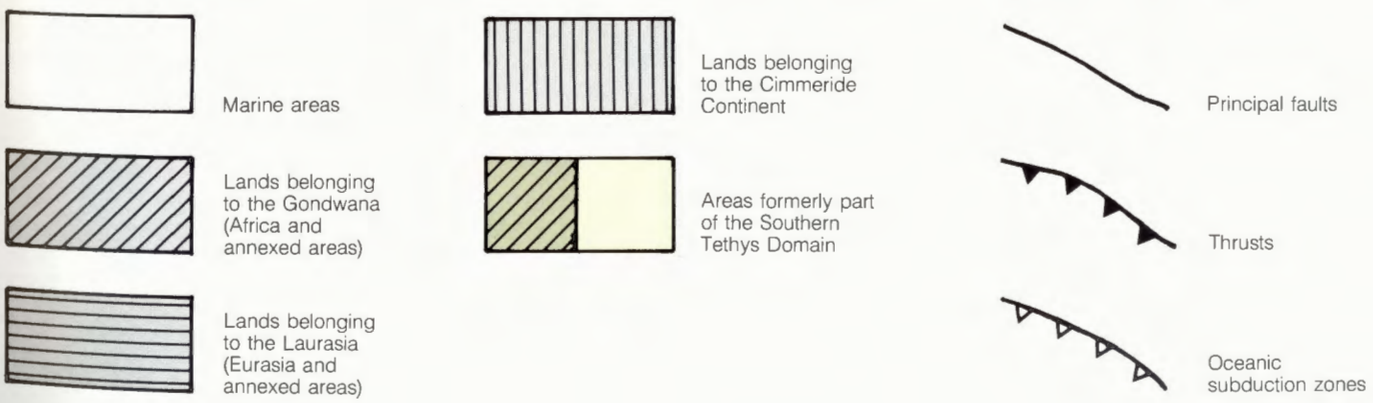


Fig. 2. **PRESENT**: Areas formerly part of the Southern Tethys Domain. Modified from DERCOURT *et alii* 1985 and ŞENGÖR 1984.



READING KEY

The contents of the Atlas are arranged in order to facilitate a rapid consultation. The following must be kept in mind:

NAMES OF FOSSILS (Fig. 3A):

The name or names of fossils are listed next to each photograph. The specific names of many forms were deliberately omitted, as focusing attention on the genus only was thought to be more useful.

AGE AND GEOGRAPHIC LOCATION (Fig. 3B):

The name of each fossil is followed by the age and geographic location of the collected sample.

RANGE OF FORMS (Fig. 3C):

The boxes containing the ages also include bold continuous lines, which define the maximum frequency range of the forms represented. Dashed bold lines represent an uncertain and/or controversial maximum frequency range. Thin lines represent the total range of the illustrated forms, while dashed thin lines represent uncertain and/or controversial total range.

NOTES AND OBSERVATIONS (Fig. 3D):

Some morphological, taxonomical, paleogeographic, etc. notes are added in order to supply further information on the illustrated fossil.

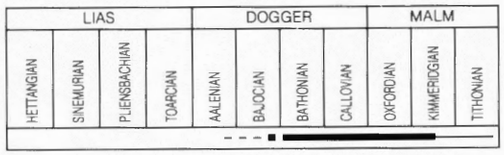
CHAPTER ARRANGEMENT:

The volume is subdivided into five chapters in stratigraphic order: Paleozoic, Triassic, Jurassic, Cretaceous and Cenozoic.
a) Within each chapter, except for the Paleozoic, various forms are presented according to their environment from shallow-water to basin. For example, while limited space is dedicated to Triassic basinal biofacies, in the Jurassic and later, pelagic biofacies are progressively examined more closely, in relation to the evolution and increasing stratigraphic importance of planktonic microfossils.
b) The first part of each chapter is dedicated to shallow platform biofacies, followed by basinal facies.
c) In the Cenozoic chapter a further distinction is made between environmentally protected and open circulation biofacies. The Cenozoic is therefore divided into protected and open shallow-water biofacies and basin biofacies.
d) The most important calcareous Algae are also included. They are grouped at the end of the shallow platform biofacies of each chapter except for those of Jurassic and Cretaceous age. These are arranged in stratigraphic order with the other different fossils of shallow platform in the Jurassic and Cretaceous chapters.
e) Many forms belonging to the same family (e.g. Fusulinidae, Duostominidae, *etc.) are grouped together in summarizing tables to stress their importance as markers.*

A and B

Protopreneroplis striata WEYNSCHENK (X 90). DOGGER of Matumbi Hills, Tanzania.

C



D

Oolitic facies with Protopeneroplis are present in Tanzania and Madagascar. They identify the extreme southern border of the Southern Tethys Domain during the JURASSIC.

Fig. 3

BIOFACIES AND ENVIRONMENT PLATES:

The Atlas ends with eight simplified tables, in which some biofacies typical of a specific environment from the Paleozoic through the Cenozoic are summarized. Each diagram idealizes a certain number of biofaces of approximately the same age, whose paleontological content may indicate a particular environment. Bearing in mind that these diagrams are a summary, they should be considered only as tentative and not final; thus they could vary from area to area.

TABLES OF MICROPALEONTOLOGICAL BIOEVENTS:

In these tables the most significant bioevents recognizable in thin section (e.g. the first occurrence and disappearance of the main microfossil groups) are schematically plotted in stratigraphic order. They are located before the illustrate part of the Atlas in order to avoid a micropaleontological-biostratigraphic discussion in each chapter.

REFERENCE LIST:

A list of selected references includes some important general works to which all workers interested in biofacies and microfacies study could refer in addition to those cited in the text.

MICROPALEONTOLOGICAL BIOEVENTS

EARLY PALEOZOIC	Primitive forms of foraminifers and algae.
EARLY CARBONIFEROUS	Occurrence and spreading of different forms of foraminifers and algae.
LATE CARBONIFEROUS-PERMIAN	Maximum spreading of *Fusulinidae* facies.
LATEST PERMIAN	Extinction of *Fusulinidae* and of nearly all the different foraminiferal genera of the Carboniferous and Permian.
PERMIAN-TRIAS BOUNDARY	Global crisis period.
SCYTHIAN-EARLY ANISIAN	Scarce fauna, prevalently *Ammodiscidae* and *Fischerinidae.*
ANISIAN	Occurrence of *Duostominidae.*
LATEST ANISIAN-LADINIAN	*Diplopora annulata* and *Teutloporella nodosa* algal facies.
LADINIAN-CARNIAN	Occurrence and spreading of *Triadodiscus* and *Lamelliconus.*
NORIAN-RHAETIAN	Maximum spreading and differentiation of *Involutinacea* superfamily.
RHAETIAN	Occurrence of *Triasina hantkeni.*
LATEST RHAETIAN	Extinction of *Duostominidae.*
EARLY LIAS	*Involutinacea* is present with new forms (*Involutina liassica* etc.).
MIDDLE LIAS	Significant spreading of *Valvulinidae* facies. *Orbitopsella* and *Palaeoclasydadus* facies.
DOGGER	Occurrence of *Protopeneroplis striata.* Occurrence and evolution of *Pfenderinidae.* Occurrence of first planktonic foraminiferal facies.
MALM	Disappearance of *Pfenderina* and occurrence of *Kurnubia.*
LATE MALM	Spreading of *Clypeina jurassica.* Occurrence of first *Calpionellidae,* preceded by the *Saccocoma* facies.
EARLIEST CRETACEOUS	Maximum spreading of *Calpionellidae* facies.
EARLY CRETACEOUS	Occurrence of *Cuneolina.*
VALANGINIAN	Extinction of *Calpionellidae.*
LATEST BARREMIAN-EARLY APTIAN	Significant spreading of *Orbitolinidae (Paleodictyoconus, Palorbitolina,* etc.). Constant occurrence of planktonic foraminifers.
LATE APTIAN	Most primitive *Alveolinidae.* Spreading of planktonic foraminiferal facies.
ALBIAN	Start of first significant *Miliolidae* facies. Planktonic assemblages, in which *Ticinella* and *Hedbergella* prevail.
LATEST ALBIAN	Spreading of *Cuneolina pavonia* and new *Orbitolinidae (Neoiraqia, etc.).* Occurrence of *Rotalipora* and *Planomalina buxtorfi.*

CENOMANIAN	Maximum diversification and spreading of *Nezzazatidae*. Occurrence of new *Alveolinidae (Praealveolina, Sellialveolina,* etc.). Spreading of *Rotalipora*.
MIDDLE CENOMANIAN	Extinction of *Orbitolina* genus.
CENOMANIAN-TURONIAN BOUNDARY	Reduction in benthonic fauna and decrease in keeled forms of planktonic foraminifers.
LATE TURONIAN-CONIACIAN	Start of significant spreading of double-keeled planktonic foraminifers (*Marginotruncana, Dicarinella).*
CONIACIAN-SANTONIAN	Maximum spreading of *Dicyclina* facies.
LATEST SANTONIAN	First occurrence of *Orbitoides.*
CAMPANIAN	New development in single-keeled planktonic foraminifers (*Globotruncana elevata, Globotruncana stuartiformis,* etc.).
MAASTRICHTIAN	Significant spreading of *Orbitoididae* and *Siderolites.* Maximum development and spreading of large *Heterohelicidae* and high-trochospiral planktonic foraminifers (*Globotruncana contusa).*
CRETACEOUS-TERTIARY BOUNDARY	Extinction of *Orbitoididae* and *Globotruncanidae.*
EARLIEST PALEOCENE	Small globigerinids followed by globular *Globorotaliidae* facies.
LATE PALEOCENE	*Glomalveolina, Coskinolina,* and *Fallotella* facies. Occurrence of *Discocyclina, Nummulites* and *Orbitolites.*
EARLY EOCENE	Maximum spreading of *Alveolina* facies. Significant development of ornamented planktonic foraminifers (*Morozovella subbotinae, Morozovella formosa,* etc.).
MIDDLE EOCENE	Maximum spreading of *Nummulites* facies. Occurrence of *Hantkenina, Globigerinatheka,* and *Turborotalia* gr. *cerroazulensis.*
MIDDLE-LATE EOCENE BOUNDARY	Disappearance of *Alveolina* facies. Extinction of ornamented planktonic forms.
LATE EOCENE	*Spiroclypeus/Pellatispira* facies.
EOCENE-OLIGOCENE BOUNDARY	Disappearance of *Discocyclina.* Extinction of *Turborotalia* gr. *cerroazulensis, Hantkenina* and *Globigerinatheka.*
EARLY OLIGOCENE	Last significant *Nummulites* facies.
MIDDLE OLIGOCENE	Occurrence of *Lepidocyclinidae.* Significant spreading of *Meandropsina, Archaias* and *Austrotrillina* facies.
LATEST OLIGOCENE	Occurrence of *Miogypsinoides.*
EARLY MIOCENE	Occurrence of *Miogypsina.* Spreading of *Globigerinoides* and *Globoquadrina.*
EARLY-MIDDLE MIOCENE BOUNDARY	Extinction of *Lepidocyclinidae.*
MIDDLE-LATE MIOCENE	*Borelis* facies. *Orbulina* facies.