Stratigraphic Classifications

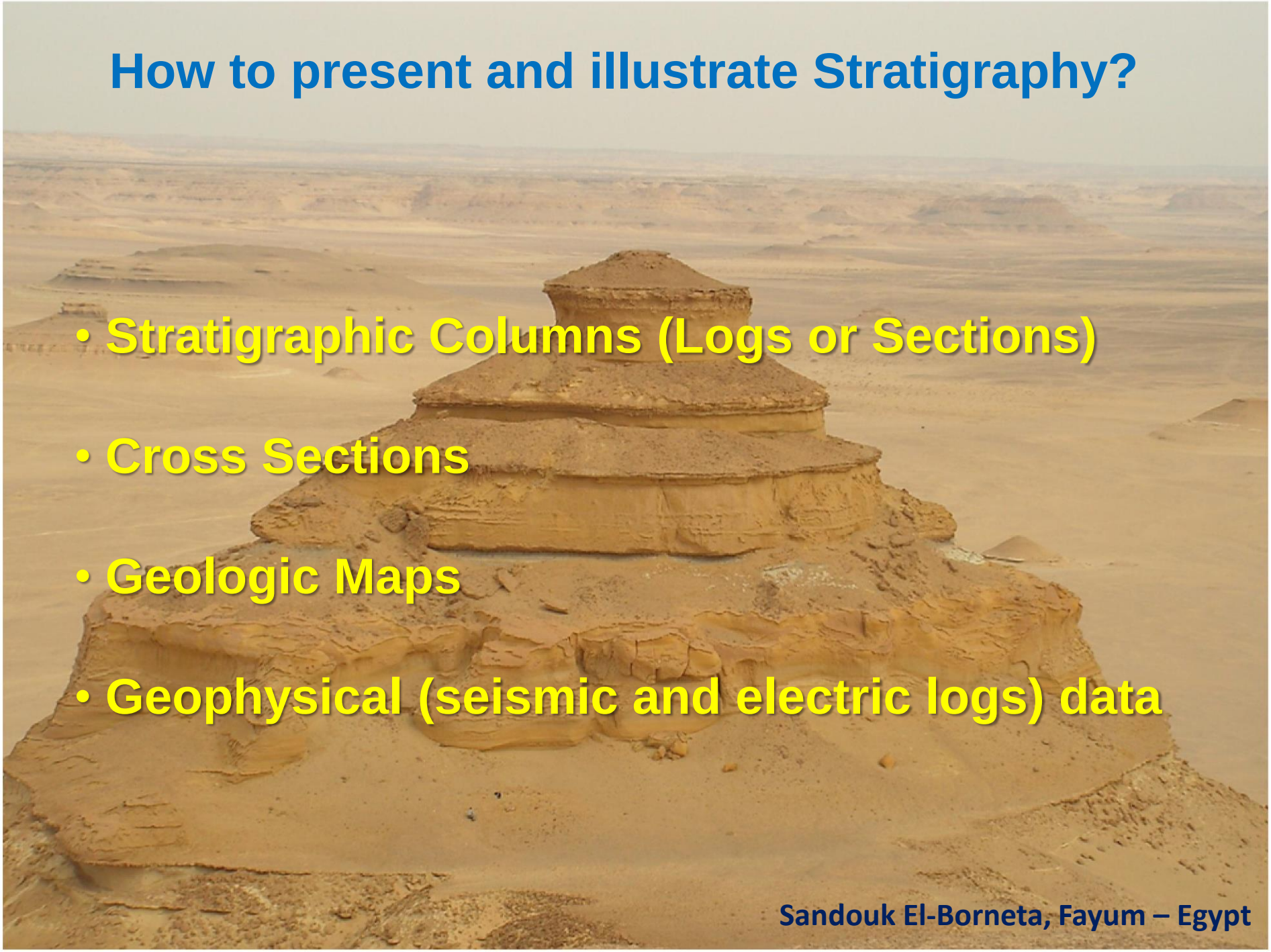
(Subdivision of Rock Record)

- **Classic Stratigraphy**
  1- Lithostratigraphy
  2- Chronostratigraphy and Geochronology
  3- Biostratigraphy
  4- Magnetostratigraphy

- **Modern Stratigraphy**
  1- Allostratigraphy
  2- Cyclostratigraphy
  3- Event stratigraphy
  4- Chemostratigraphy
  5- Sequence stratigraphy (Genetic Stratigraphy)

Grand Canyon- USA

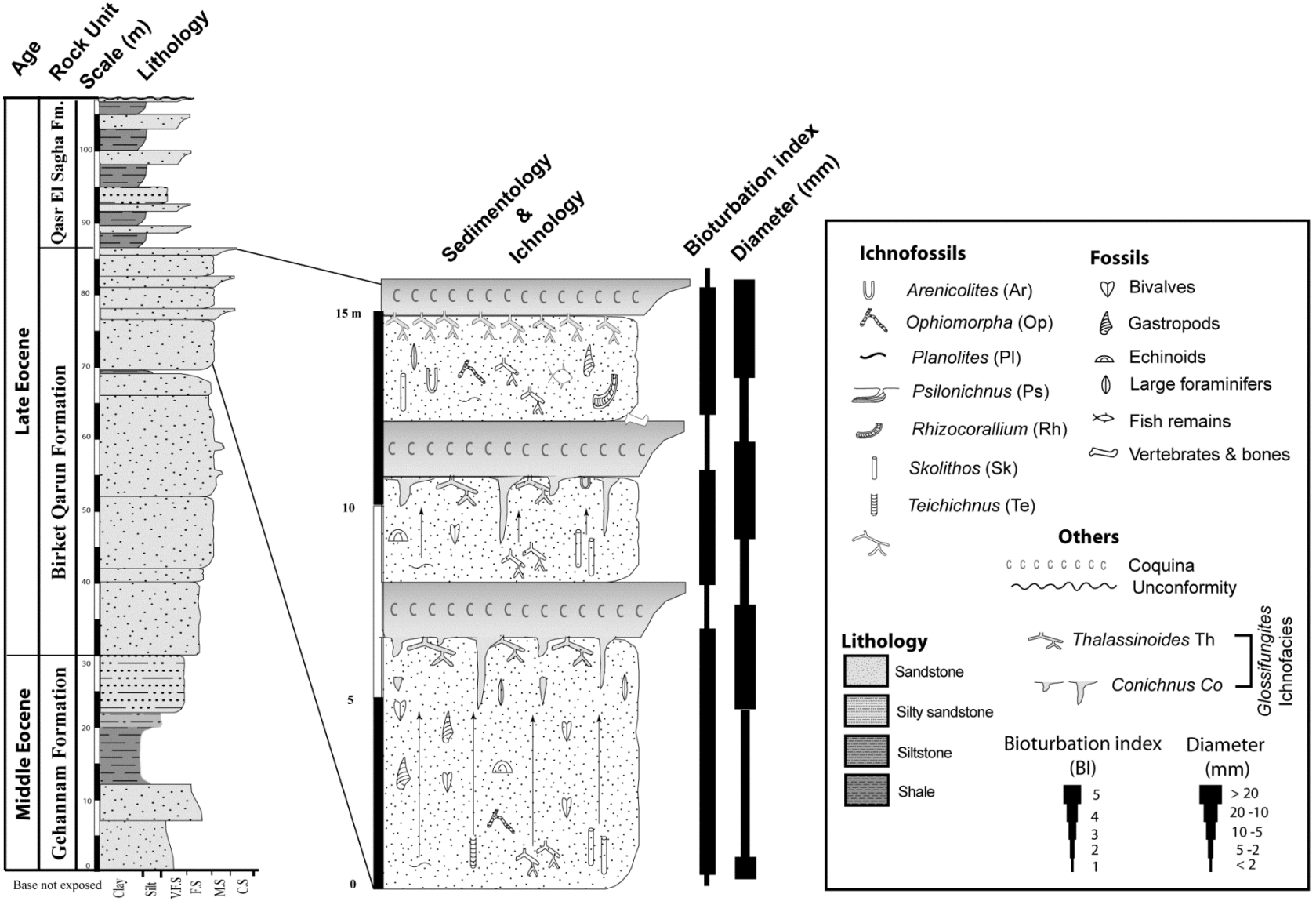
How to present and illustrate Stratigraphy?



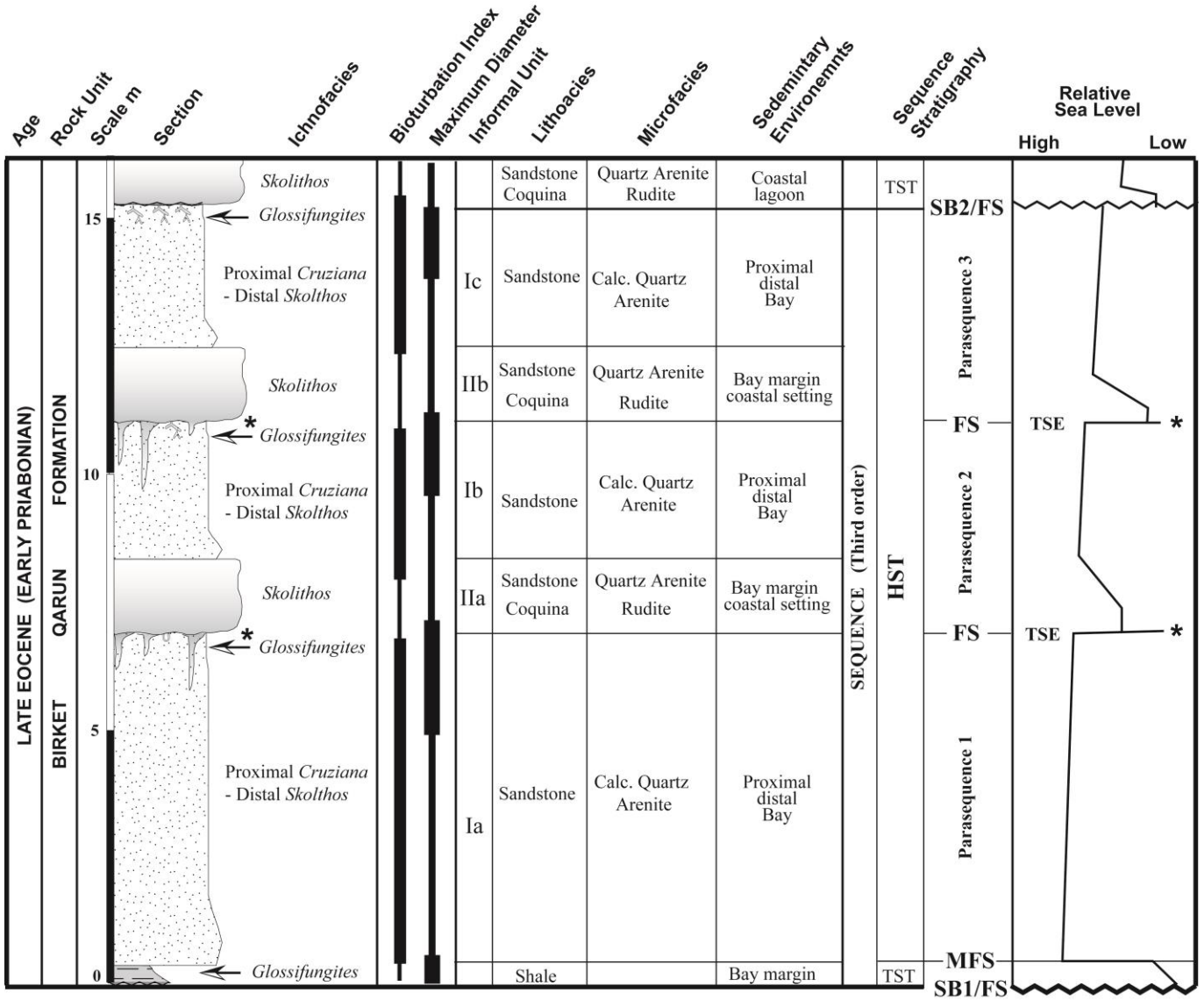
- Stratigraphic Columns (Logs or Sections)
- Cross Sections
- Geologic Maps
- Geophysical (seismic and electric logs) data

Sandouk El-Borneta, Fayum – Egypt

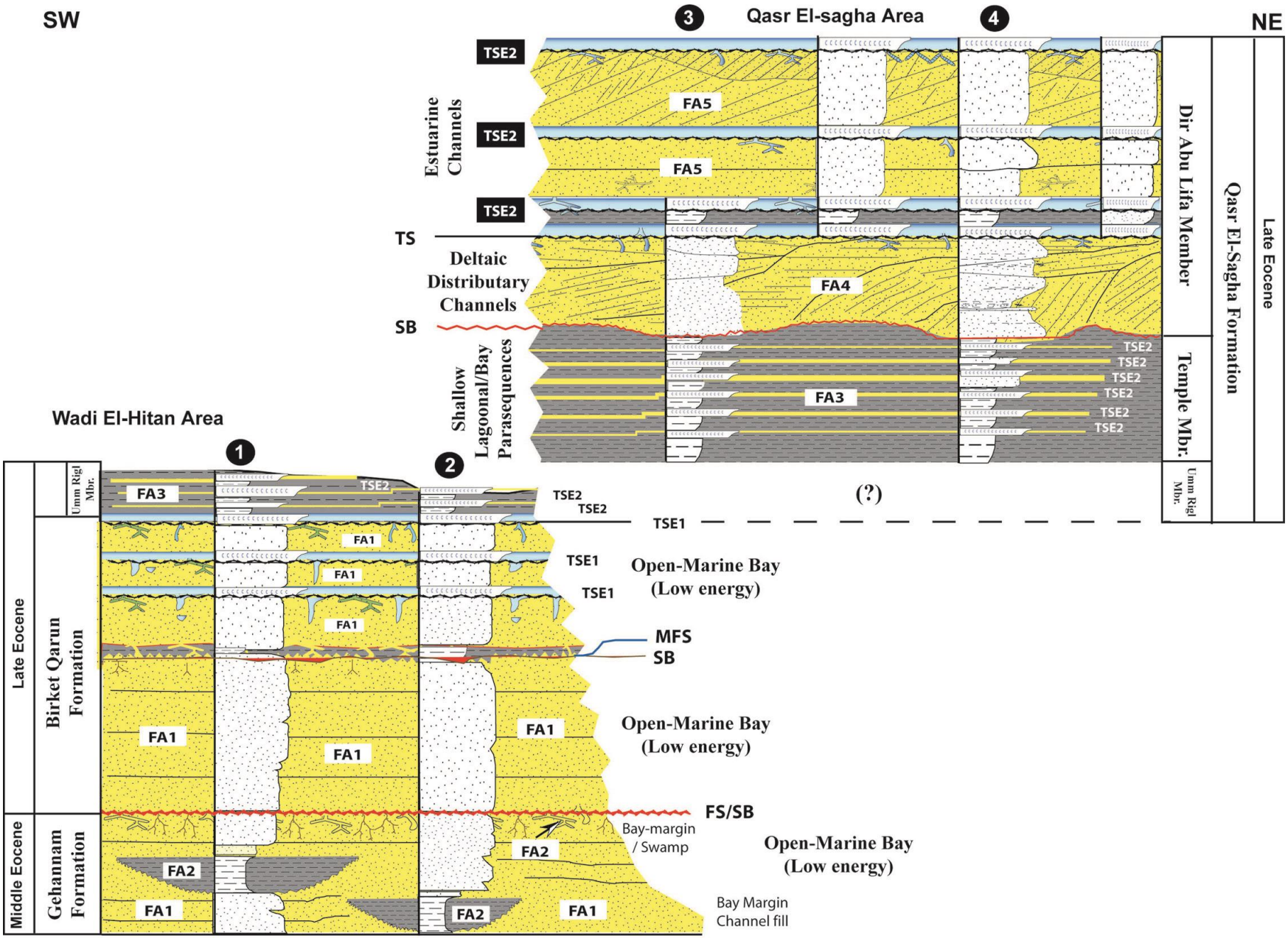
Stratigraphic Column



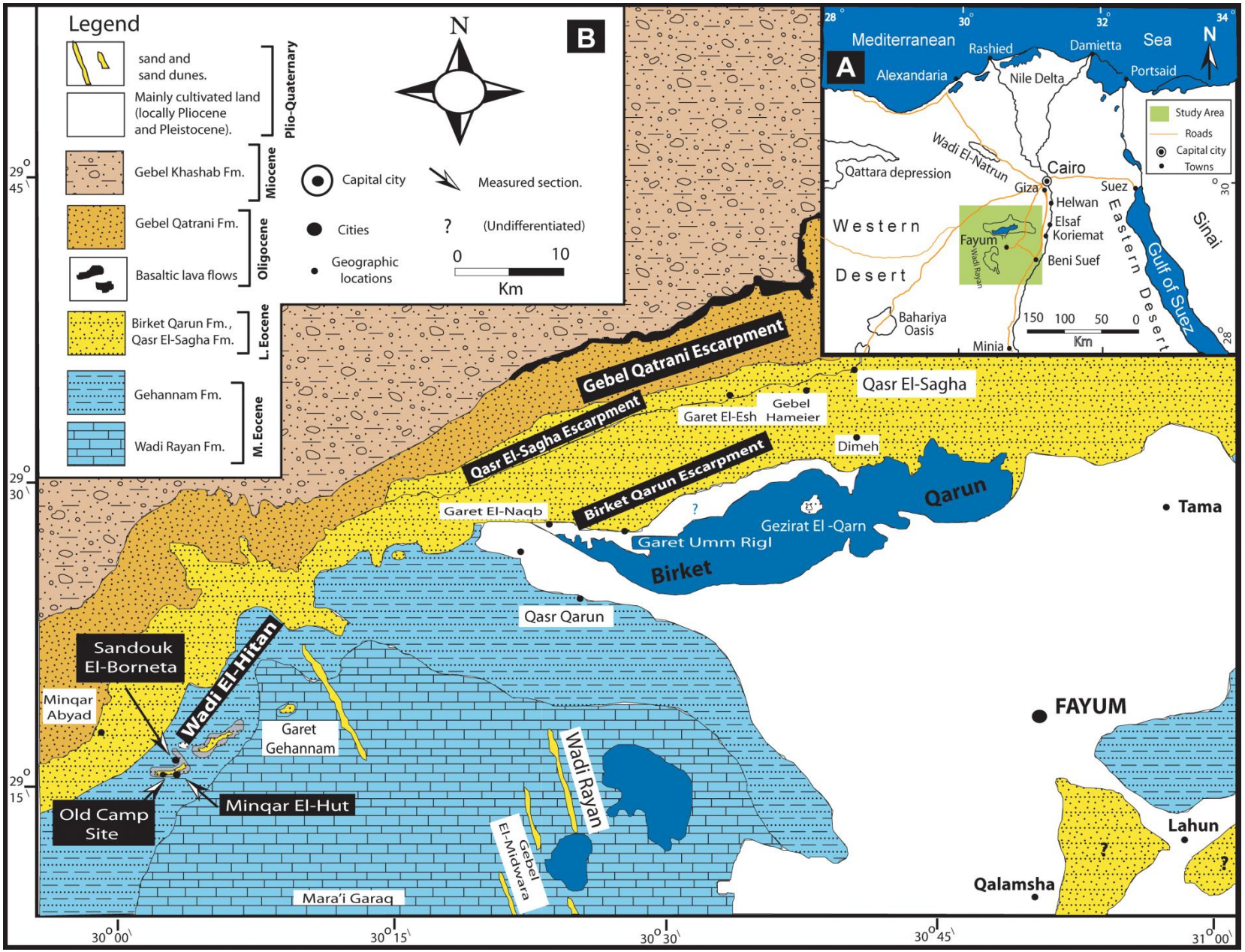
Stratigraphic Column



Cross Section



Geologic Map



Classic Stratigraphic Classifications

1- Lithostratigraphy

2- Chronostratigraphy and Geochronology

3- Biostratigraphy

4- Magnetostratigraphy

Stratigraphic classification	Units and terms
Lithostratigraphic (Lithology)	**Supergroup** **Group** **Formation** **Member** Bed
Biostratigraphic (Fossil content)	(**Biozones**): **Range Zone** **Interval Zone** **Lineage Zone** **Assemblage Zone** **Abundance Zone**
Chronostratigraphic (time-rock)	**Eonothem** **Erathem** **System** **Series** **Stage** **Chronozone**
Geochronologic (absolute time)	**Eon** **Era** **Period** **Epoch** **Age** **Chron**

1- LITHOSTRATIGRAPHY

Lithostratigraphic Classification is the organization of rock bodies into units on the basis of their lithologic properties and their stratigraphic relations.

Lithostratigraphic unit (Hierarchy of units)

Super Group: Two groups or more

Group: Two or more formations

Formation: ***Primary unit of Lithostratigraphy***

Member: Named lithologic subdivision of a formation

Bed: Named distinctive layer in a member or formation

Flow: Smallest distinctive layer in a volcanic sequence

Formation is the only formal lithostratigraphic units into which the stratigraphic column everywhere should be divided completely on the basis of lithology. The thickness of formations may range from less than a meter to several thousand meters. Formation must be mapable.

From NASC, 2005

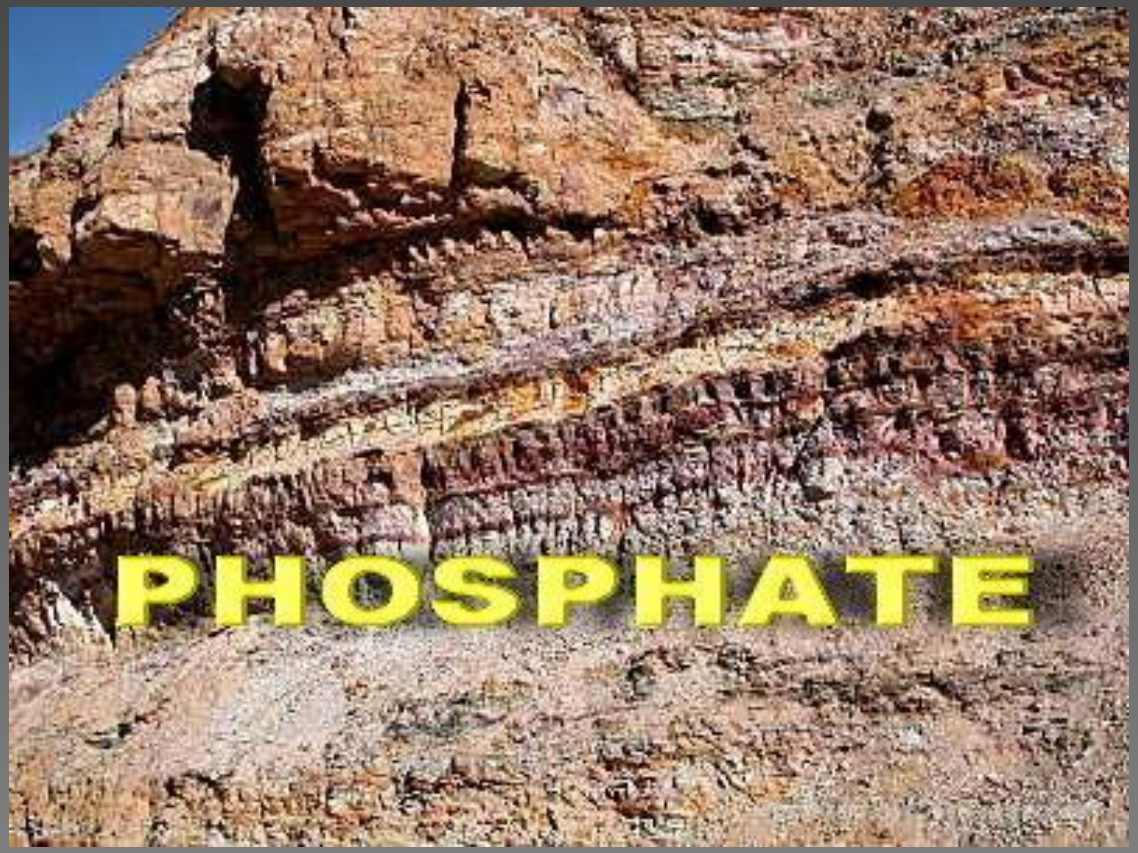
Esna + Shale or Esna + Formation

Thebes Formation

- Thebes: Old name of Luxorr
- Limestone with chert bands

Member: The formal lithostratigraphic unit next in rank below a formation. It possesses lithologic properties distinguishing it from adjacent parts of the formation. A formation need not be divided into members unless a useful purpose is thus served. A member may extend from one formation to another.

Bed: Ths smallest formal lithostratigraphic unit is a single stratum lithologically distinguishable from other layers above and below. Only distinctive beds (key beds, marker beds) particularly useful for stratigraphic purposes are given proper names and considered formal lithostratigraphic units.



Phosphate bed:
Cretaceous of Egypt
Eastern Desert
along Red Sea Coast

Flow: A discrete extrusive volcanic body distinguishable by texture, composition, or other objective criteria. The designation and naming of flows as formal lithostratigraphic units should be limited to those that are distinctive and widespread.

Basaltic Flow of Gabal Widan El-Faras

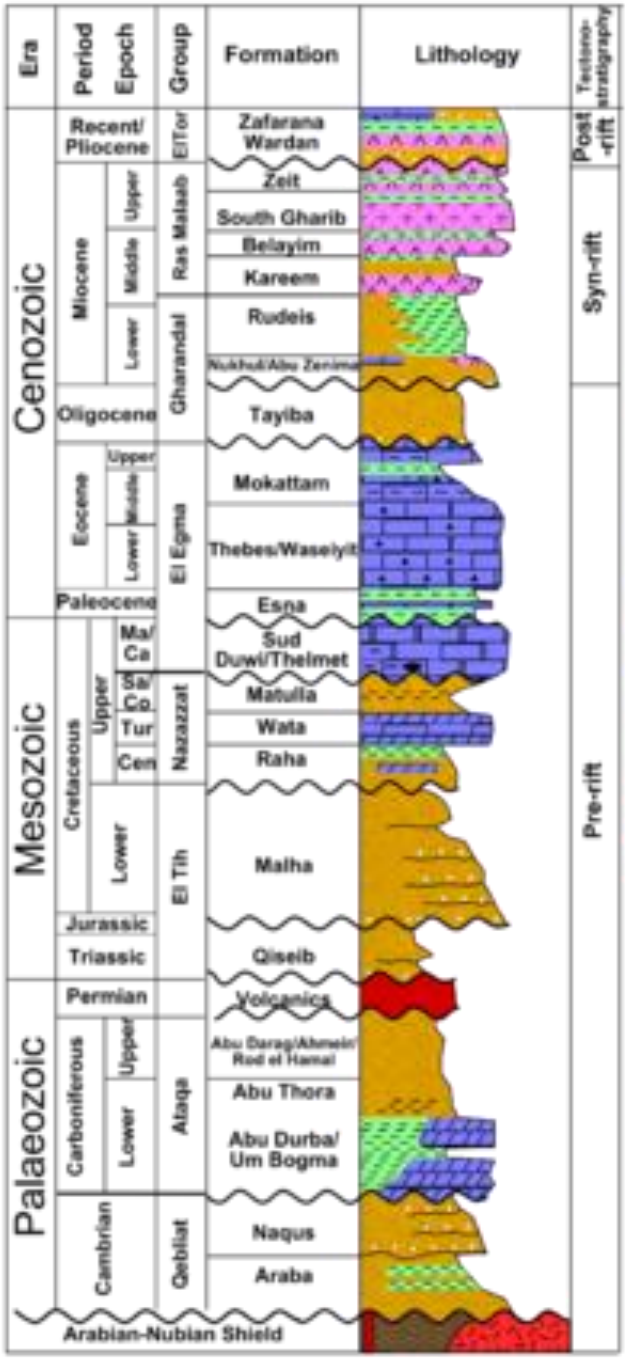
Gebel Qatrani Formation
Fayum

Group: A succession of two or more contiguous or associated formations with significant and diagnostic lithologic properties in common. Formations need not be aggregated into groups unless useful means are needed. Thickness of a stratigraphic succession is not a valid reason for defining a unit as a group rather than a formation.

Supergroup and subgroup: The term "supergroup" may be used for several associated groups or for associated groups and formations with significant lithologic properties in common. Exceptionally, a group may be divided into subgroups.

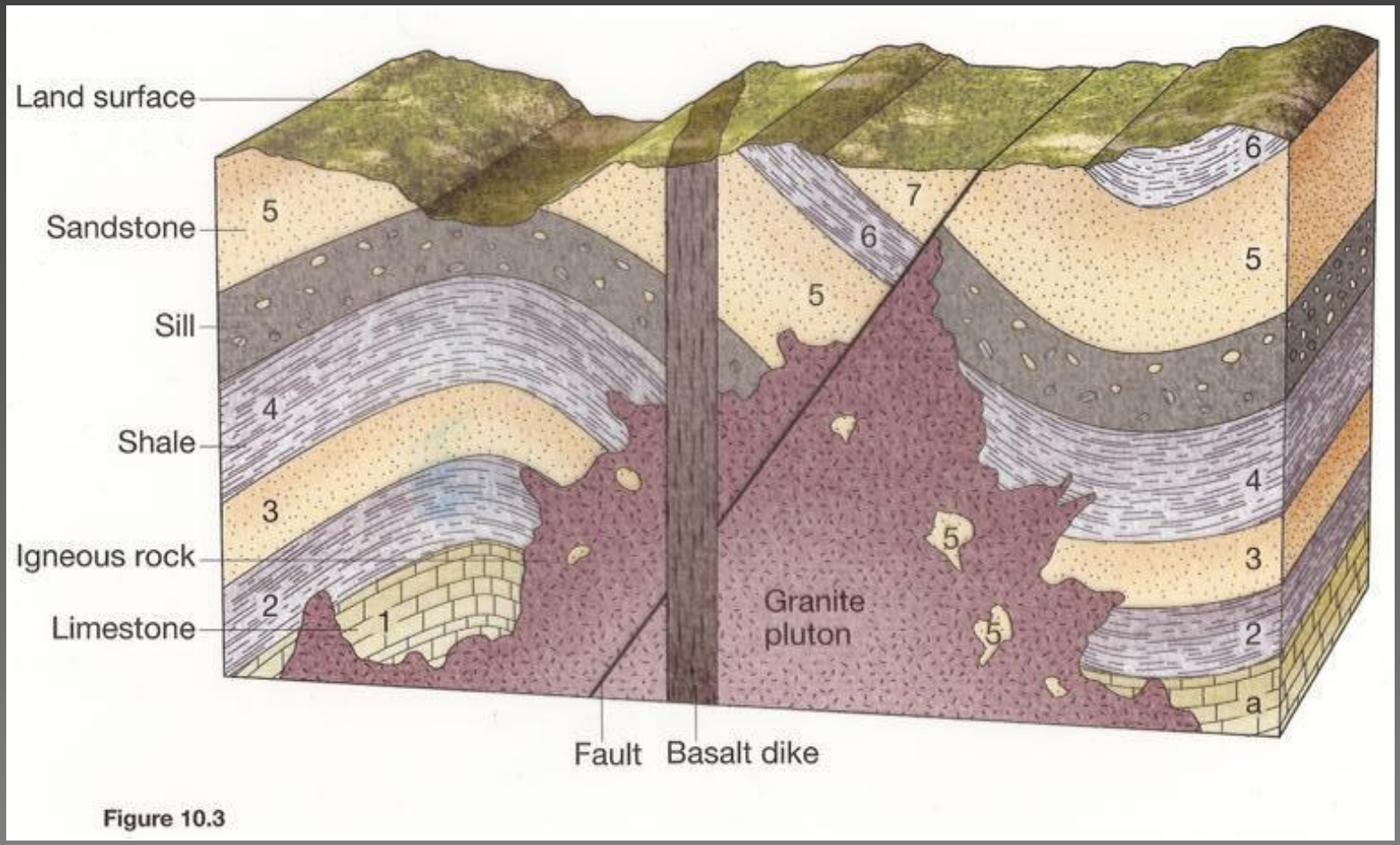
Complex: A lithostratigraphic unit composed of diverse types of any class or classes or rocks (sedimentary, igneous, metamorphic) and characterized by irregularly mixed lithology or by highly complicated structural relations.

Lithostratigraphic horizon (Lithohorizon): A surface of lithostratigraphic change, commonly the boundary of a lithostratigraphic unit, or a lithologically distinctive very thin marker bed.



Pre-rift Eocene strata unconformably overlain by Miocene clastics. Gulf of Suez

A lithodemic unit is a defined body of predominantly intrusive, highly metamorphosed, or intensely deformed rock that, because it is intrusive or has lost primary structure through metamorphism or tectonism. Unlike lithostratigraphic units, generally does not conform to the Law of Superposition.



A lithodemic unit

Faulted dike
Sinai - Egypt

Cross-cutting dikes
Sinai - Egypt

Pedostratigraphic terms and classifications

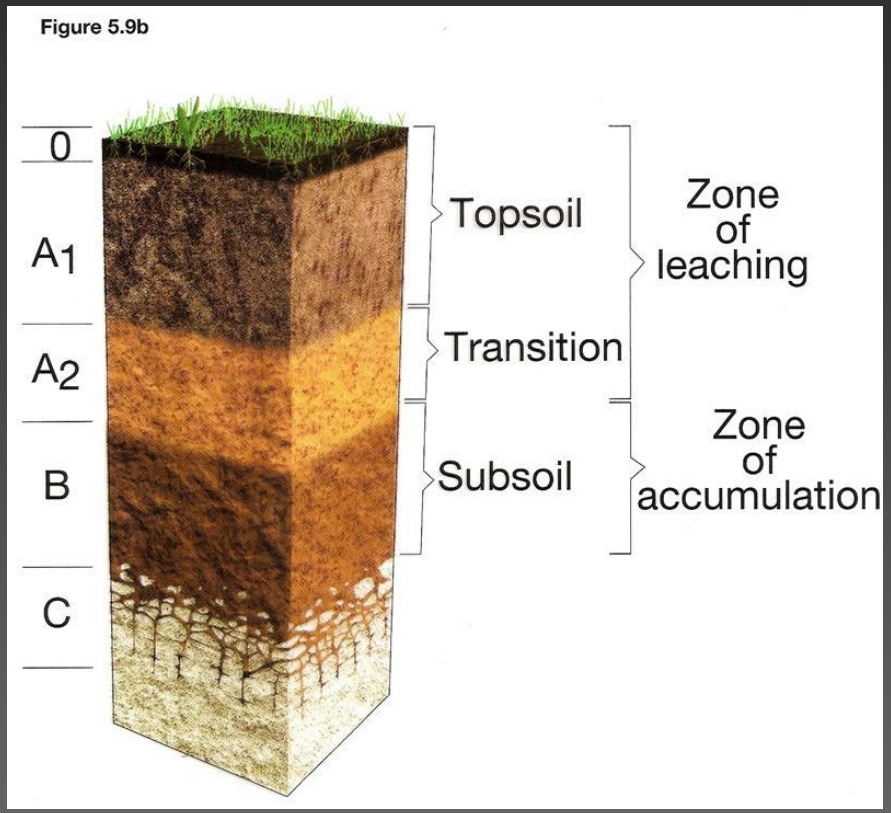
- **The term paleosol is currently used for any soil that formed on a landscape of the past.**

- **A pedologic soil is composed of one or more soil horizons.**

- **A soil horizon is a layer within a pedologic soil that:**
  (1) is approximately parallel to the soil surface;
  (2) has distinctive physical, chemical, biological, and morphological properties that differ from those of adjacent, genetically related, soil horizons; and
  (3) is distinguished from other soil horizons by objective compositional properties that can be observed or measured in the field.

From NASC, 2005

Pedostratigraphic Unit: Geosol
(first proposed by Morrison, 1964) is the **fundamental** and **only** unit in pedostratigraphic classification.
In general**, a geosol** is a buried and lateral soil profile range that is characterized by several important or dominant soil types, which are recognized and described in stratigraphic context. The **upper boundary** of a pedostratigraphic unit is the **top** of the **uppermost pedologic horizon** formed by pedogenesis in a buried soil profile. The **lower boundary** of a pedostratigraphic unit is **the lowest** definite physical boundary of a pedologic horizon within a buried soil profile

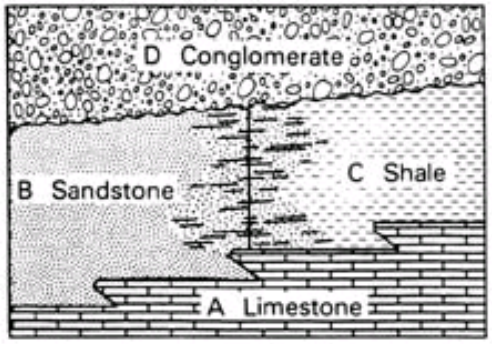


A pedostratigraphic unit is a body of rock that consists of one or more pedologic horizons

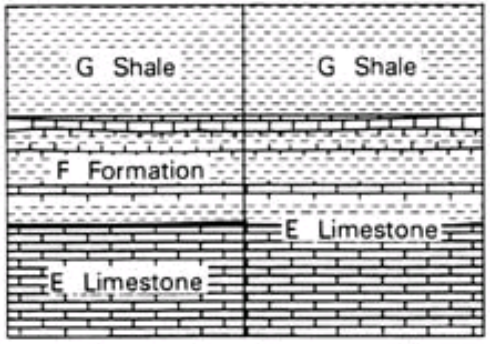
From NASC, 2005

Boundaries between Lithostratigraphic Units

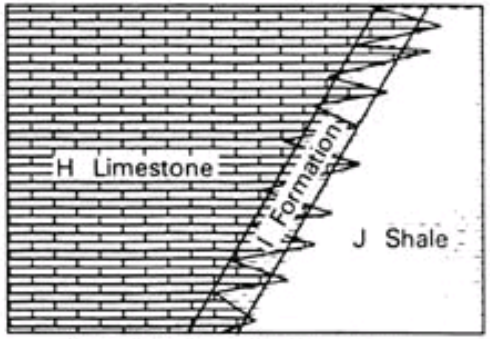
Boundaries of lithostratigraphic units are placed at positions of lithic change. Boundaries are placed at distinct contacts or may be selected at some arbitrary level within zones of gradation. Both vertical and lateral boundaries are based on the lithic criteria that provide the greatest unity and utility.



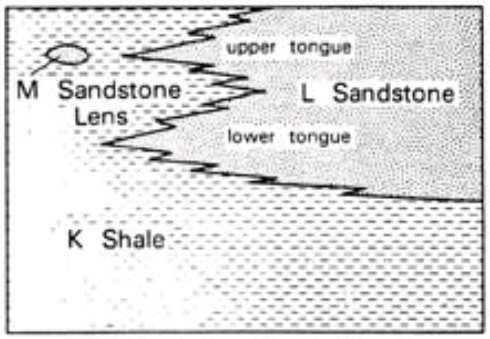
A.--Boundaries at sharp lithologic contacts and in laterally gradational sequence.



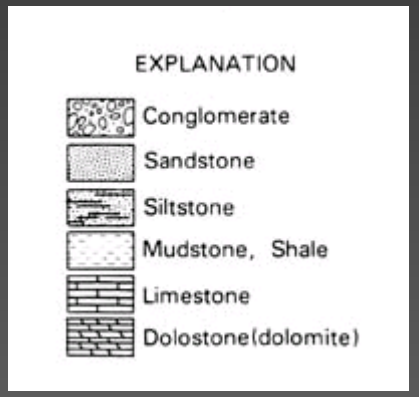
B.--Alternative boundaries in a vertically gradational or interlayered sequence.

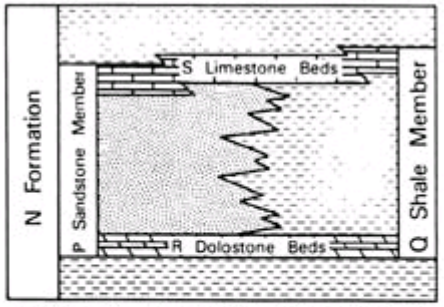


C.--Possible boundaries for a laterally intertonguing sequence.



D.--Possible classification of parts of an intertonguing sequence.



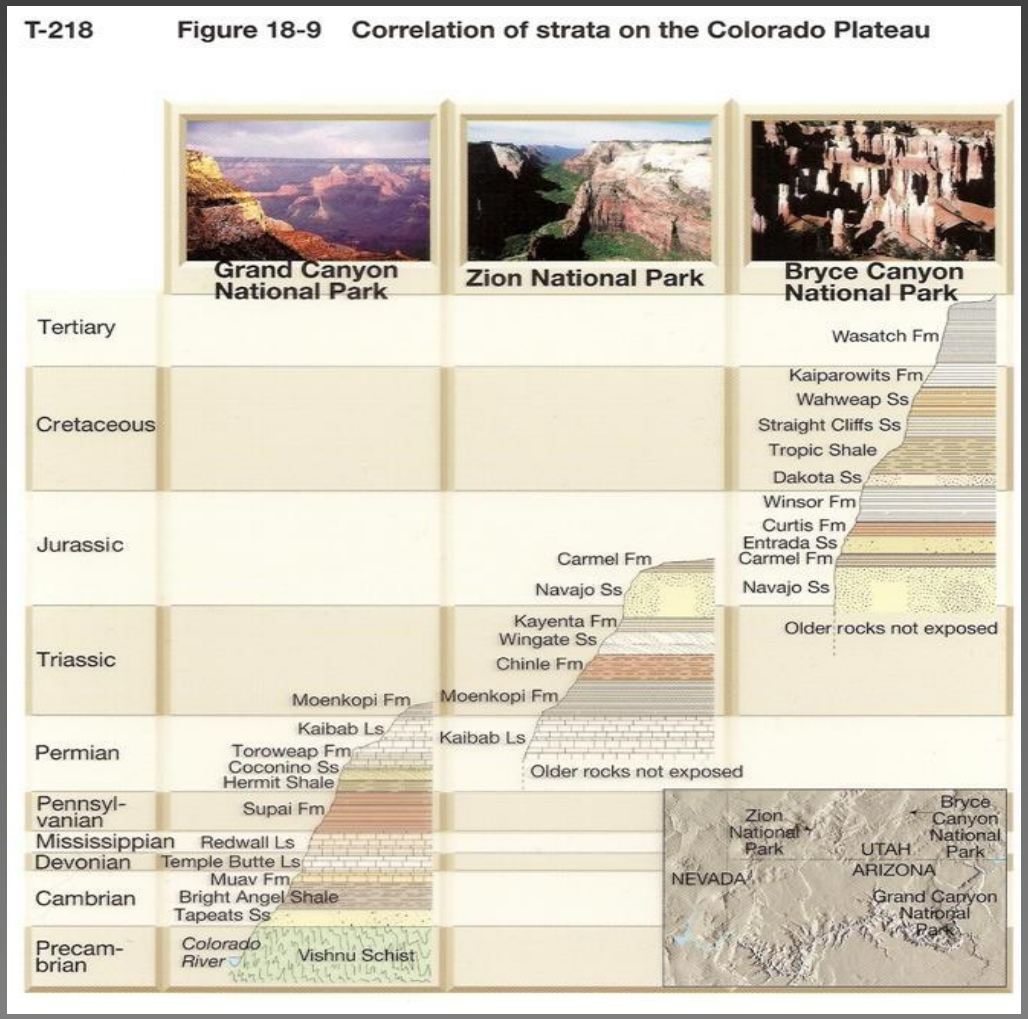


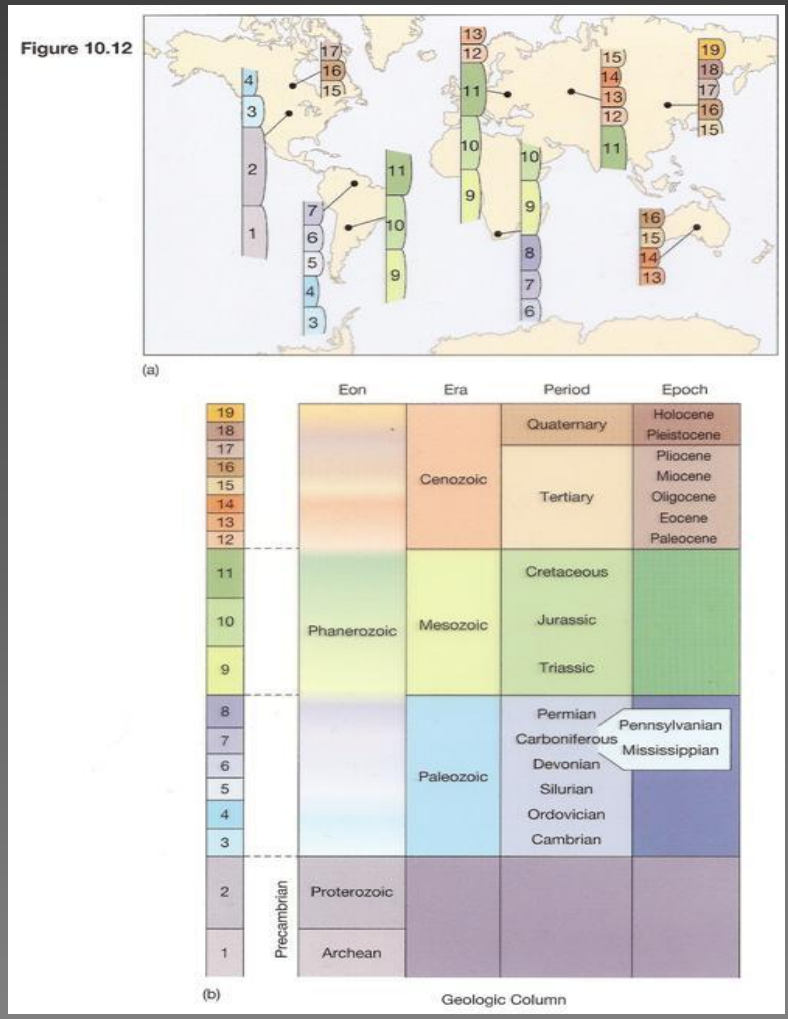
E.--Key beds, here designated the R Dolostone Beds and the S Limestone Beds, are used as boundaries to distinguish the Q Shale Member from the other parts of the N Formation. A lateral change in composition between the key beds requires that another name, P Sandstone Member, be applied. The key beds are part of each member.

From NASC, 2005

Correlation of Lithostratigraphic Units

Correlation is a procedure for demonstrating correspondence between geographically separated parts of a geologic unit. The term is a general one having diverse meanings in different disciplines. Demonstration of temporal correspondence is one of the most important objectives of stratigraphy.





Stratotype (type section):

A stratotype is the specific stratal sequence used for the definition and/or characterization of the stratigraphic unit or boundary being defined. The designated exposure (standard of reference) is commonly used. Subsurface stratotypes are acceptable if adequate surface sections are lacking.

NAME : Geographic Locality + Word (Formation, Group, Member)
or Lithic designation
(First letter Capitalized) (First letter Capitalized)

In the case of lateral changes in lithologic composition, change in the geographic term is desirable for important regional changes, but not for minor lithologic variations.

Formal and Informal Lithostratigraphic Units

Formally named units are those that are named in accordance with an established scheme of classification; the fact of formality is conveyed by capitalization of the initial letter of the *rank* or *unit* term (for example, Rosetta Formation). Informal units, whose unit terms are ordinary nouns, are not protected by the stability provided by proper formalization and recommended classification procedures.

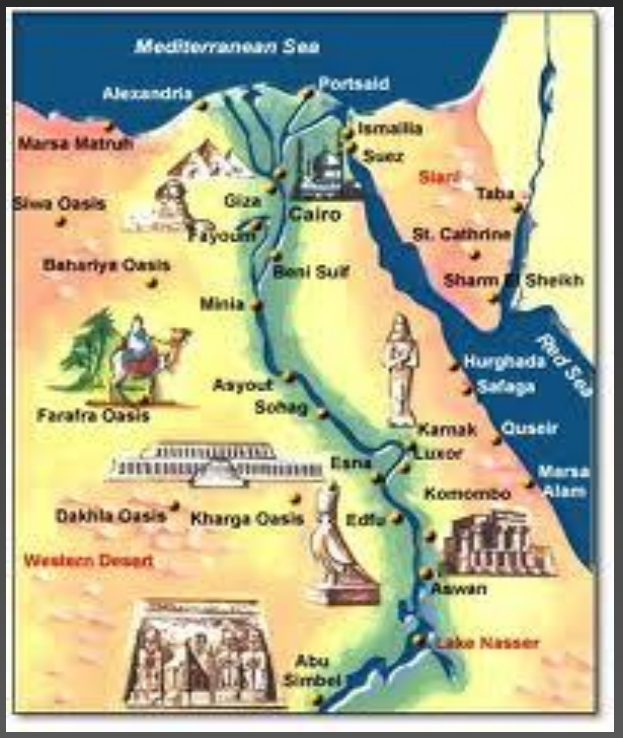
Requirements for Formally Named Geologic Units. Naming, establishing, revising, redefining, and abandoning formal geologic units require publication in a recognized scientific medium of a comprehensive statement which includes:

- **intent to designate or modify a formal unit;**
- **designation of category and rank of unit;**
- **selection and derivation of name;**
- **specification of stratotype (where applicable);**
- **description of unit;**
- **definition of boundaries;**
- **historical background;**
- **dimensions, shape, and other regional aspects;**
- **geologic age;**
- **correlations; and possibly**
- **genesis (where applicable).**

From NASC, 2005

Example: (description of a formal Lithostratigraphic Unit):

Esna Formation



Author: Said (1960)

Type section: Gebel Oweina, Esna, Nile Valley

Lithology (at Type section): Shale

Thickness (at Type section): 104 m

Stratigraphic limits: Overlies Tarwan Formation, and underlies Thebes Group

Areal distribution: Nile Valley, South Western Desert, Eastern Desert, Safaga-Quseir district, Red Sea Coast and Sinai

Fossil: Rich in foraminifera (*Morozovella subbotina* and *M. formosa* zone)

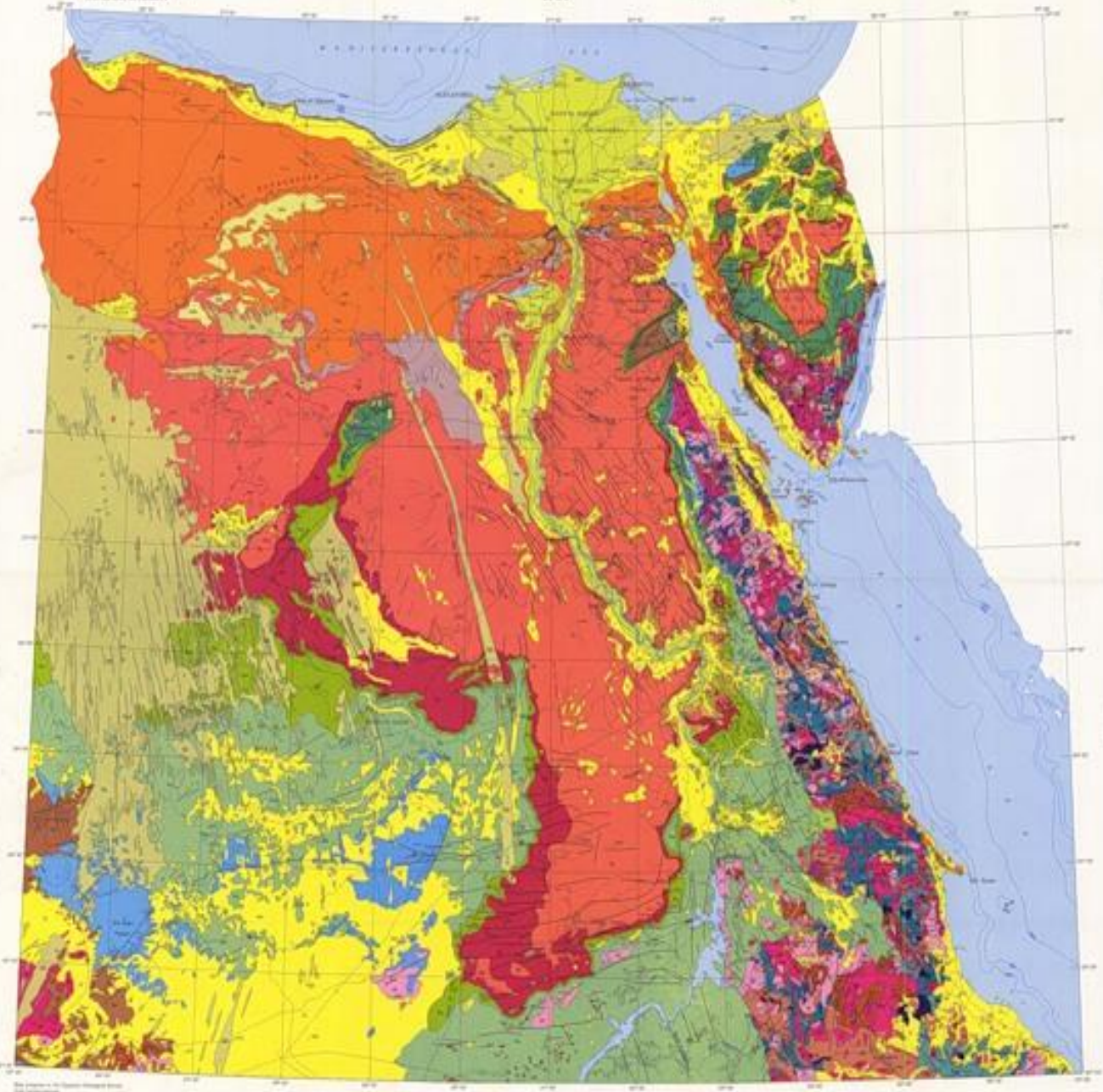
Age: Late Paleocene to Early Eocene

References: Beadnell 1905, Said 1962, Said And Sabry 1964, El Nagar 1970

MINISTRY OF INDUSTRY
AND MINERAL RESOURCES
THE EGYPTIAN GEOLOGICAL SURVEY
AND MINING AUTHORITY

GEOLOGIC MAP OF EGYPT

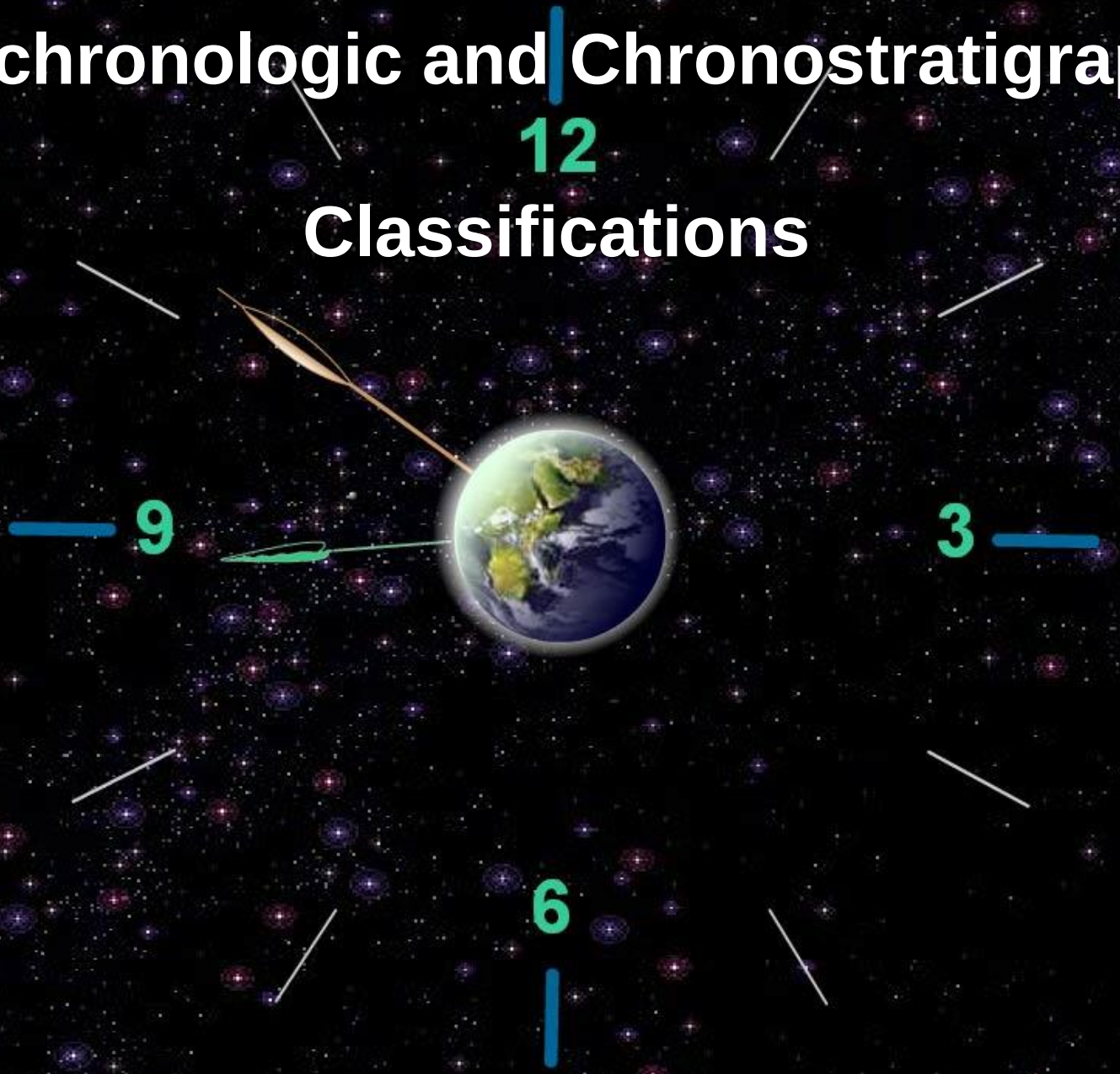
1981



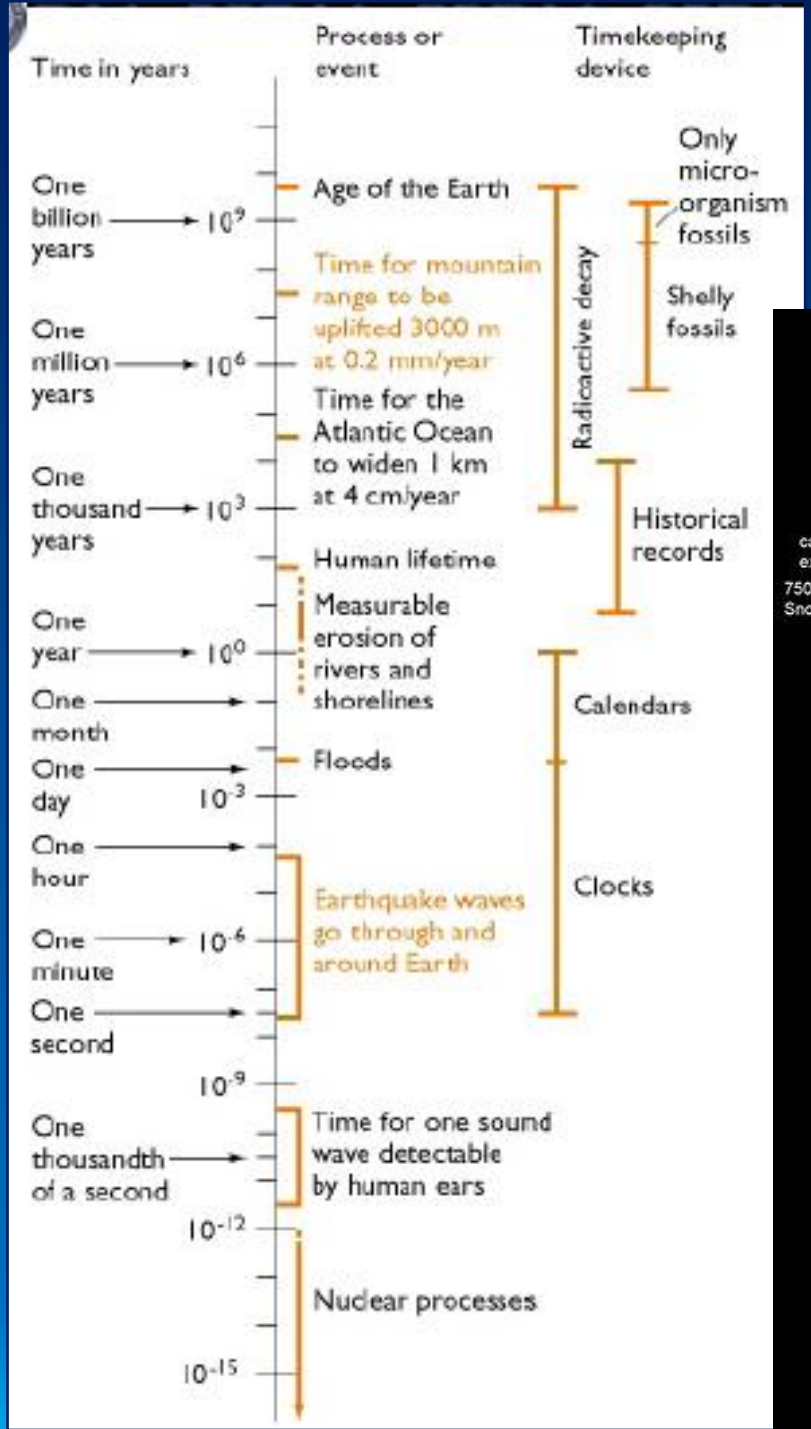
GEOLOGIC MAP OF EGYPT
SCALE 1:2 000 000
1981

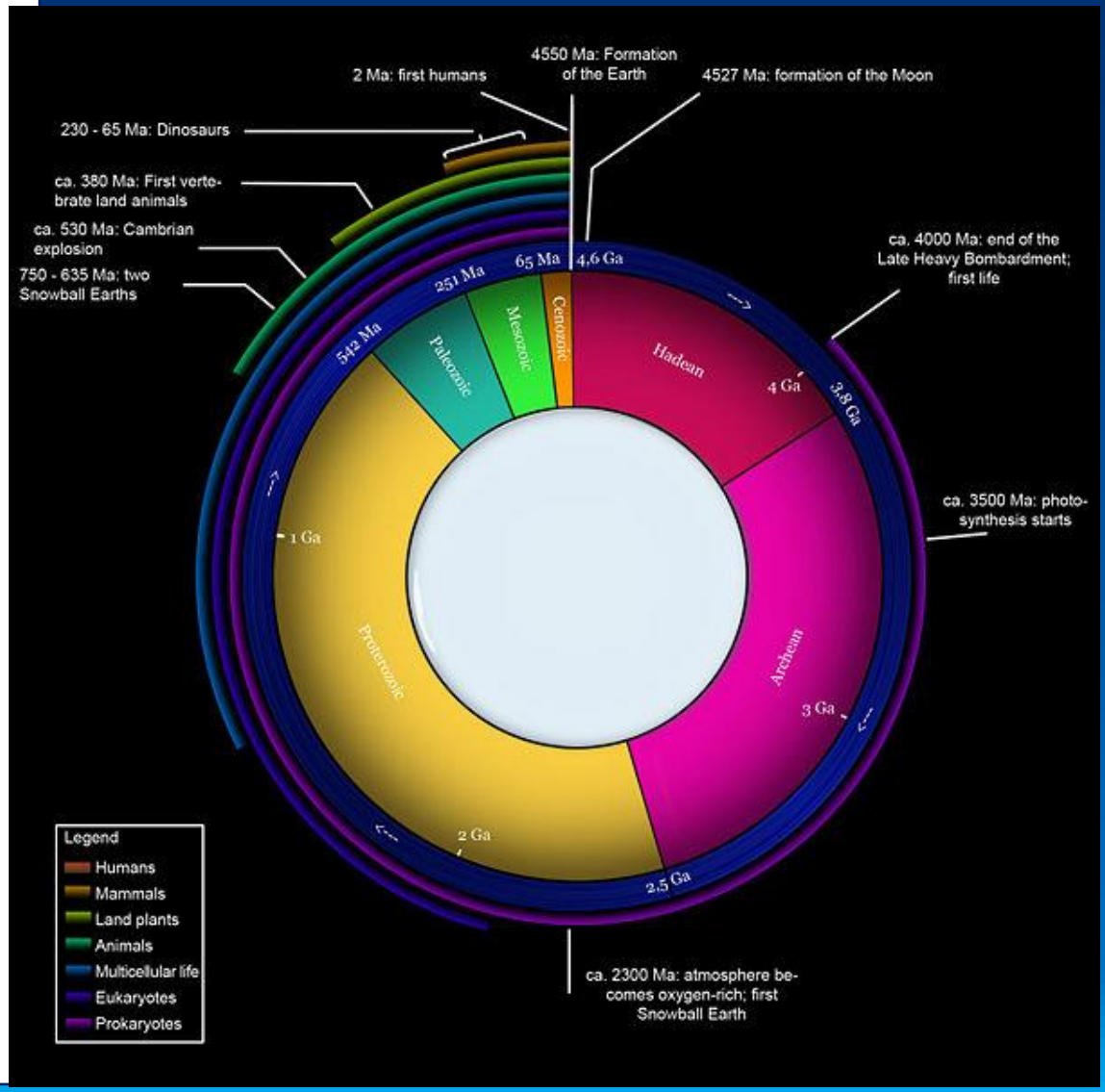
EXPLANATION

Geochronologic and Chronostratigraphic Classifications



Geology deals with wide ranges of times and events





Geochronologic and Chronostratigraphic Classifications

Hierarchy of formal chronostratigraphic and geochronologic unit terms

Table 3

From NASC, 2005

Conventional Hierarchy of Formal Chronostratigraphic and Geochronologic Terms.

Chronostratigraphic	Geochronologic
Eonothem	Eon
Erathem	Era
System*	Period*
Series*	Epoch*
Stage†	Age
Substage	Subage or age

* *If additional ranks are needed, the prefixes sub and super may be used with these terms.*

† *Several adjacent stages may be grouped into a superstage (see section 9.C.3).*

Time-Rock Unit

(basal, lower, middle, upper)

Time Unit

(early, middle, late)

Chronostratigraphic Classifications

- **Chronostratigraphy:** is the element of stratigraphy that deals with the relative time relations and ages of rock bodies, as well as the organization of rocks into units on the basis of their age or time of origin.

- **Chronostratigraphic unit:** A body of rocks that includes all rocks formed during a specific interval of geologic time, and only those rocks formed during that time span. Chronostratigraphic units are bounded by synchronous horizons.

- **Chronostratigraphic horizon (Chronohorizon):** A stratigraphic surface or interface that is synchronous, everywhere of the same age.

Kinds of Chronostratigraphic Units

1. Eonothem (and Eon):

An eonothem is a chronostratigraphic unit greater than an erathem. The geochronologic equivalent is an eon. Three eonothems are generally recognized, from older to younger, the Archean, Proterozoic and Phanerozoic eonothems. The combined first two are usually referred to as the Precambrian. The eons take the same name as their corresponding eonothems.

2. Erathem (and Era):

An erathem consists of a group of systems. The geochronologic equivalent of an erathem is an era. The names of erathems were chosen to reflect major changes of the development of life on the Earth: Paleozoic (old life), Mesozoic (intermediate life), and Cenozoic (recent life). Eras carry the same name as their corresponding erathems.

3. System (and Period):

A system is a unit of major rank in the conventional chronostratigraphic hierarchy, above a series and below an erathem. The geochronologic equivalent of a system is a period. Occasionally, the terms subsystem and supersystem have been used. System is defined by boundary stratotypes.

The time span of the currently accepted Phanerozoic systems ranges from 30 to 80 million years, except for the Quaternary System that has a time span of only about 1.64 million years.

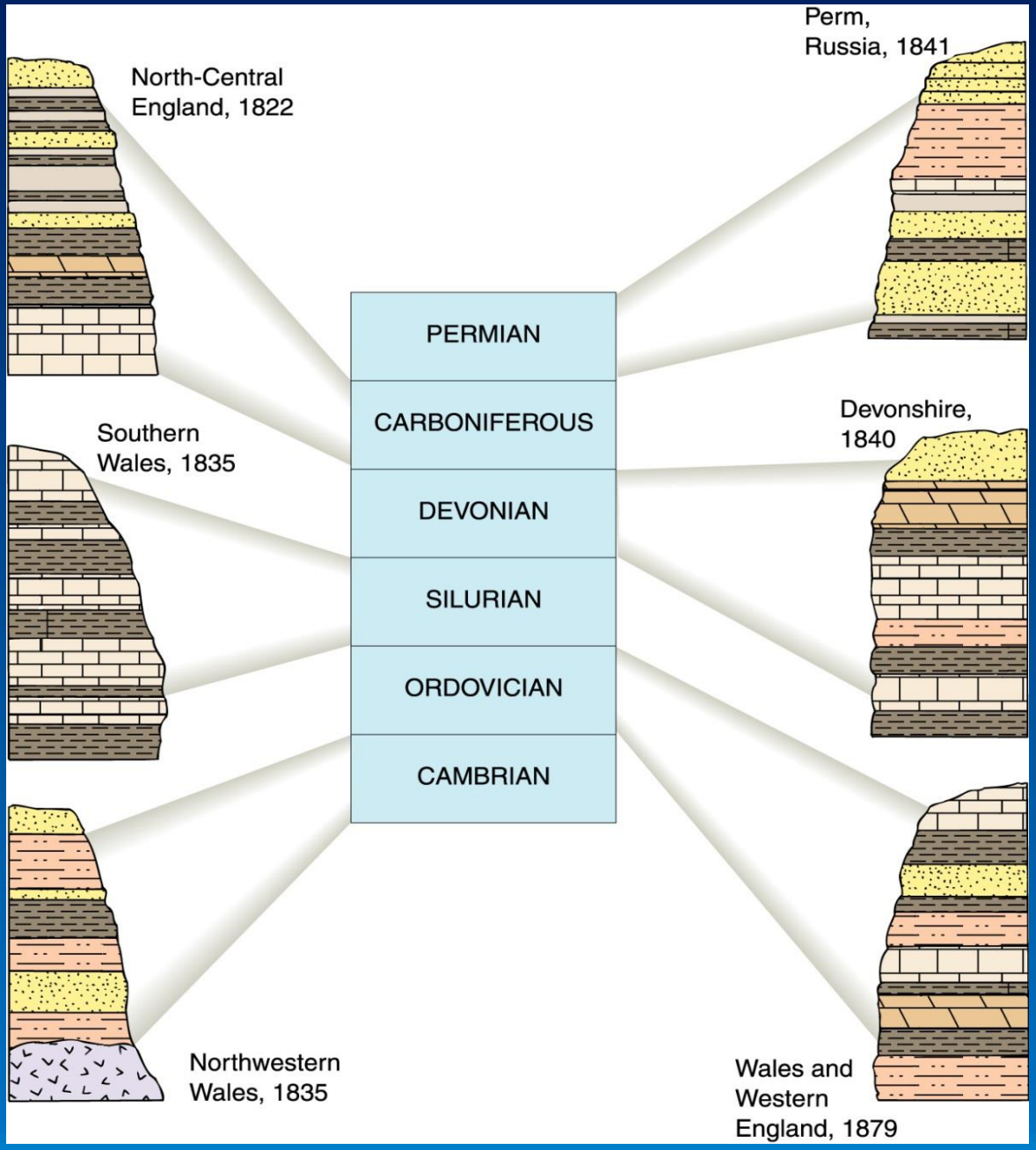
The names of currently recognized systems are of diverse origin inherited from early classifications:

1- Some indicate chronologic position (Tertiary, Quaternary),

2- Others have lithologic connotation (Carboniferous, Cretaceous),

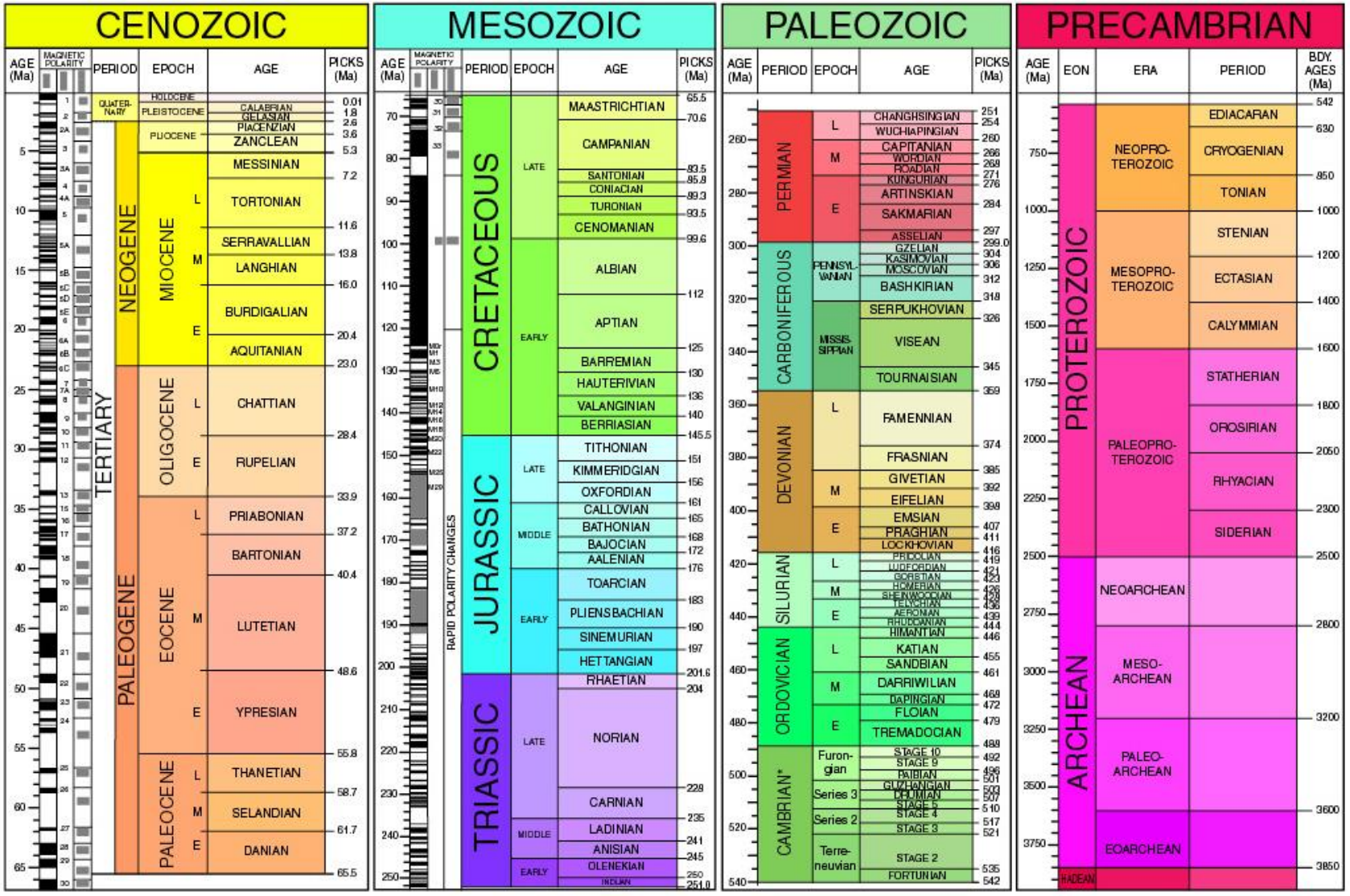
3- Others are tribal (Ordovician, Silurian), and still others are geographic (Devonian, Permian).

4- Likewise, they bear a variety of endings such as "an", "ic", and "ous". The period takes the same name as the system to which it corresponds.



Chronostratigraphy and the Development of the Geologic Time Scale

2009 GEOLOGIC TIME SCALE



*International ages have not been fully established. These are current names as reported by the International Commission on Stratigraphy.

Walker, J.D., and Geissman, J.W., compilers, 2009, Geologic Time Scale: Geological Society of America, doi: 10.1130/2009.CTS004R2C.

Sources for nomenclature and ages are primarily from Gradstein, F., Ogg, J., Smith, A., et al., 2004, A Geologic Time Scale 2004: Cambridge University Press, 589 p. Modifications to the Triassic after: Furin, S., Preto, N., Rigo, M., Roghi, G., Gianolla, P., Crowley, J.L., and Bowring, S.A., 2006, High-precision U-Pb zircon age from the Triassic of Italy: Implications for the Triassic time scale and the Carnian origin of calcareous nannoplankton and dinosaurs: Geology, v. 34, p. 1009–1012, doi: 10.1130/G22967A.1; and Kent, D.V., and Olsen, P.E., 2008, Early Jurassic magnetostratigraphy and paleolatitudes from the Hartford continental rift basin (eastern North America): Testing for polarity bias and abrupt polar wander in association with the central Atlantic magmatic province: Journal of Geophysical Research, v. 113, B06105, doi: 10.1029/2007JB005407.

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4. Series (and Epoch):

The series is a chronostratigraphic unit ranking above a stage and below a system. The geochronologic equivalent of a series is an epoch. The terms superseries and subseries have been used only infrequently. Series are defined by boundary stratotypes. The time span of currently accepted series ranges from 13 to 35 million years.

- **A new series name should be derived from a geographic feature in the vicinity of its stratotype or type area.**
- **The names of most currently recognized series, however, are derived from their position within a system: lower, middle, upper.**
- **Names of geographic origin should preferably be given the ending "ian" or "an".**
- **The use of the term "series" for a lithostratigraphic unit more or less equivalent to a group should be discontinued.**

5. Stage (and Age):

The stage is the basic working unit of chronostratigraphy that includes all rocks formed during an age. It is a subdivision of a series. A stage is defined by its boundary stratotypes, preferably marine. The lower and upper boundary stratotypes of a stage represent the time interval between them is the time span of the stage.

Currently recognized stages vary in time span, but most range between 2 and 10 million years. The thickness of the strata in a stage and its duration in time are independent variables of widely varying magnitudes.

The name of a stage should be derived from a geographic feature in the vicinity of its stratotype or type area.

6. Substage and Superstage:

A substage is a subdivision of a stage whose equivalent geochronologic term is subage. Adjacent stages may be grouped into a superstage. Names of substages and superstages follow the same rules as those of stages.

7. Chronozone (nonhierarchical formal chronostratigraphic units):

A chronozone is a formal chronostratigraphic unit of unspecified rank. It is the body of rocks formed anywhere during the time span of some designated stratigraphic unit or geologic feature. The corresponding geochronologic unit is the chron.

For instance, a formal chronozone based on the time span of a biozone includes all strata equivalent in age to the total maximum time span of that biozone regardless of the presence or absence of fossils diagnostic of the biozone (see Figure below).

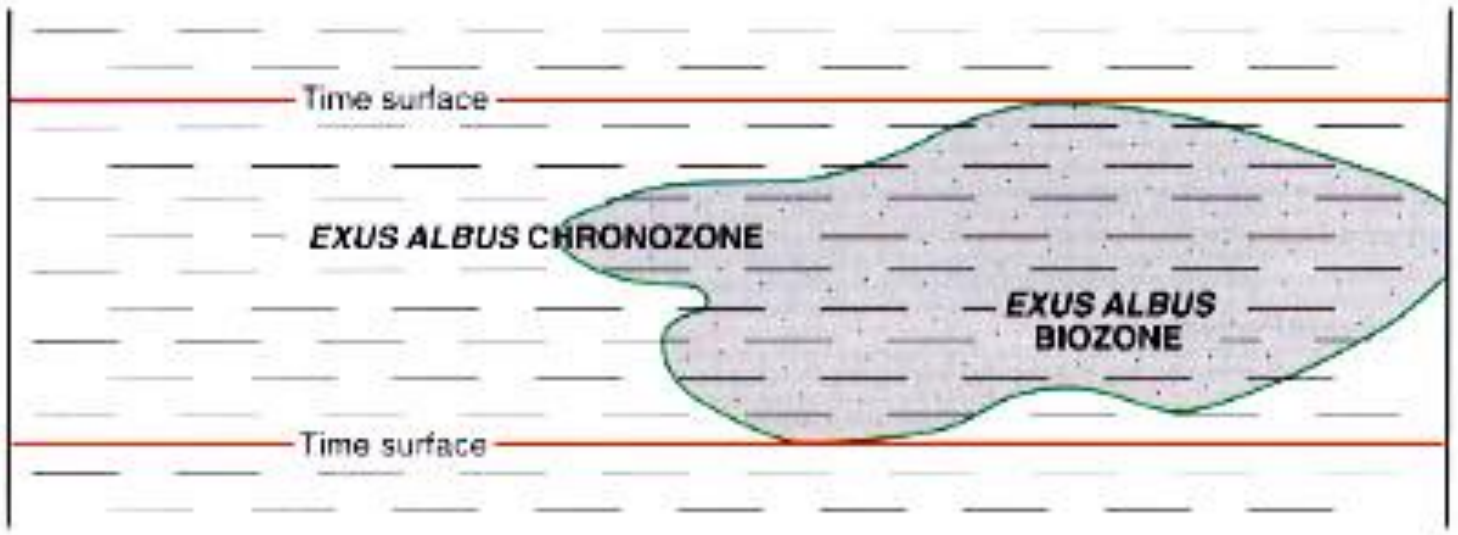


Figure 8: Relation between *Exus albus* Chronozone and *Exus albus* Biozone. (Distribution of specimens of *Exus albus* shown by dot-pattern.)

Geographic extent of a chronozone is, in theory, worldwide, but its applicability is limited to the area over which its time span can be identified. A chronozone takes its name from the stratigraphic unit on which it is based, e.g., *Exus albus* Chronozone, based on the *Exus albus* Range Zone.

The Standard Global Chronostratigraphic (Geochronologic) Scale

- A formal chronostratigraphic unit is given a binomial designation:
  (A **proper name** + the **term-word**)
- The **initial letters** of both are **capitalized**.
- Its **geochronologic equivalent** uses the same **proper name** combined with the equivalent geochronologic term.

Examples:

Phanerozoic Eonothem – Phanerozoic Eon

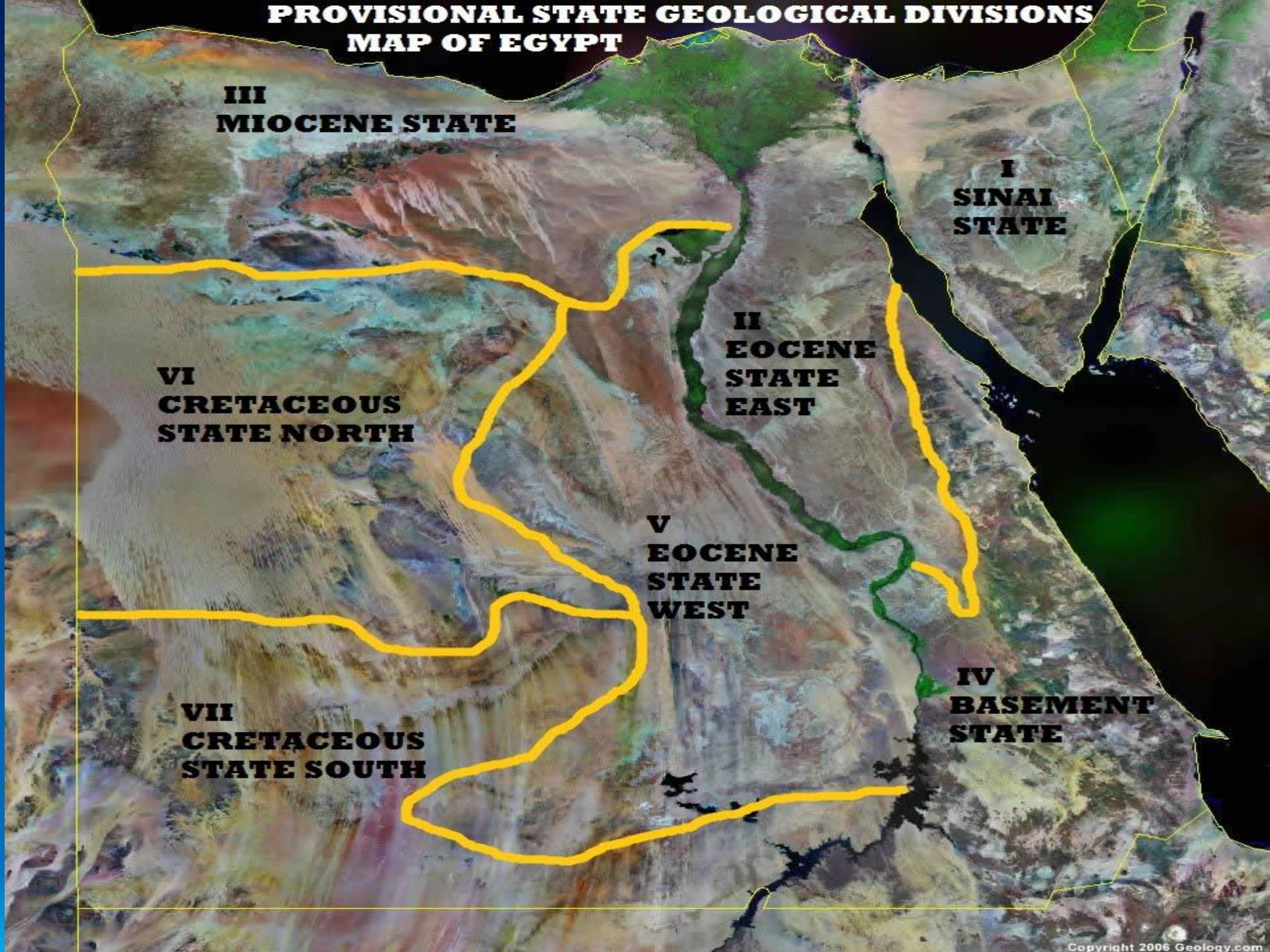
Mesozoic Erathem – Mesozoic Era

Cretaceous System – Cretaceous Period

Upper Creatceous (Series) – Late Cretaceous (Epoch)

Cenomanian (Stage) – Cenomanian (Stage)

Lower Cenomanian – Late Cenomanian (subage)


PROVISIONAL STATE GEOLOGICAL DIVISIONS
MAP OF EGYPT
III
MIOCENE STATE
I
SINAI
STATE
II
EOCENE
STATE
EAST
VI
CRETACEOUS
STATE NORTH
V
EOCENE
STATE
WEST
IV
BASEMENT
STATE
VII
CRETACEOUS
STATE SOUTH
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