

Stratigraphy



**COURSE OF STRATIGRAPHY G301
SECOND SEMESTER (FEBRUARY-JUNE, 2014)
DEPARTMENT OF GEOLOGY
COLLEGE OF SCIENCE /UNIVERSITY OF BASRAH
INSTRUCTOR: DR. NAWRAST S. ABD ALWAHAB**

Lecture 3

The Vertical Dimension



Stratigraphic categories

Principal stratigraphic unit terms

Lithostratigraphic

Defines a body of rock strata unified by overall homogeneity of lithology or combination of lithologies; may be sedimentary, metamorphic, or igneous

Group
Formation
Member
Bed(s)

Biostratigraphic

Defines a body of rock unified by its fossil content

Biozones
Assemblage zones
Range zones (various kinds)
Acme zones
Interval zones
Other kinds of biozones

Chronostratigraphic

Defines a body of rock unified by being formed all rocks during a specific interval of geologic time; represents formed anywhere during a certain segment of earth history

(Equivalent units)

Eonothem Eon
Erathem Era

System Period
Series Epoch
Stage Age
Chronozone Chron

Geochronologic

Defines a unit of geologic time determined by geologic methods; may correspond to the time-span of a stratigraphic unit



Kinds Of Geological-Times Units



- **Geologic-time units** are conceptual, rather than material, in nature. Two kinds are recognized: those based on material standards or referents (specific rock sequences or bodies), and those independent of material referents.
- **Kinds Based on Referents.** Two kinds of formal geologic-time units that are based on material referents are recognized: they are isochronous and diachronous units.

FORMAL UNITS DISTINGUISHED BY GEOLOGIC AGE		
	MATERIAL REFERENT	CORRESPONDING TIME UNIT (applicable world-wide)
UNITS BASED ON MATERIAL REFERENTS	Chronostratigraphic Polarity Chronostratigraphic	Geochronologic Polarity Chronologic
UNITS INDEPENDENT OF MATERIAL REFERENTS	None	Geochronometric
FORMAL UNITS DISTINGUISHED BY DIACHRONEITY		
	MATERIAL REFERENT	CORRESPONDING TIME UNIT (applicable only where material referent is present)
UNITS BASED ON MATERIAL REFERENTS	Lithostratigraphic Biostratigraphic Allostratigraphic Pedostratigraphic	Diachronic

Relation of geologic time units to the kinds of referents on which most are based (North American Stratigraphic Code. , 2005).

Units based on Material Referents



- **1- Isochronous Categories.** Isochronous time units and the material bodies from which they are derived are two fold: geochronologic units, which are based on corresponding material chronostratigraphic units, and polarity-chronologic units, based on corresponding material polarit chronostratigraphic units.
- **2- Diachronous Categories.** Diachronic units are time units corresponding to diachronous material allostratigraphic units, pedostratigraphic Units, and most lithostratigraphic and biostratigraphic units.

Units Independent of Material Referents



- **Numerical Divisions of Time.** Isochronous geologic-time units based on numerical divisions of time in years are geochronometric units and have no material referents.

Chronostratigraphy



- **Chronostratigraphic unit:** is a body of rock established to serve as the material reference for all constituent rocks formed during the same span of time. Each boundary is synchronous. The body also serves as the basis for defining the specific interval of time, or geochronologic unit, represented by the referent.
- **Boundaries.** Boundaries of chronostratigraphic units should be defined in a designated stratotype on the basis of observable paleontological or physical features of the rocks.



Eonothem / Eon	Erathem / Era	System / Period	Series / Epoch	Stage / Age	GSSP	numerical age (Ma)
				Tithonian		~ 145.0
			Upper	Kimmeridgian		152.1 ± 0.9
				Oxfordian		157.3 ± 1.0
				Middle	Callovian	
			Bathonian		⚡	166.1 ± 1.2
			Bajocian		⚡	168.3 ± 1.3
			Aalenian		⚡	170.3 ± 1.4
			Lower	Toarcian		174.1 ± 1.0
				Pliensbachian	⚡	182.7 ± 0.7
				Sinemurian	⚡	190.8 ± 1.0
				Hettangian	⚡	199.3 ± 0.3
						⚡

Ranks of Chronostratigraphic Units



- **Hierarchy.** The hierarchy of chronostratigraphic units, in order of decreasing rank, is eonothem, erathem, system, series, and stage.
- - **Eonothem.** The unit highest in rank is eonothem. The Phanerozoic Eonothem encompasses the Paleozoic, Mesozoic, and Cenozoic Erathems.
- *Note// Although older rocks have been assigned heretofore to the Precambrian Eonothem, they also have been assigned recently to other (Archean and Proterozoic) eonothems by the IUG Precambrian Subcommittee.*
- *The span of time corresponding to an eonothem is an eon.*



- - **Erathem.** An erathem is the formal chronostratigraphic unit of rank next lower to eonothem and consists of several adjacent systems. The span of time corresponding to an erathem is an era.
- - **System.** The unit of rank next lower to erathem is the system. Rocks encompassed by a system represent a time span and an episode of Earth history sufficiently great to serve as a worldwide chronostratigraphic reference unit. The temporal equivalent of a system is a period.



- - **Series.** Series is a conventional chronostratigraphic unit that ranks below a system and always is a division of a system. A series commonly constitutes a major unit of chronostratigraphic correlation within a province, between provinces, or between continents. The temporal equivalent of a series is an epoch.
- - **Stage.** A stage is a chronostratigraphic unit of smaller scope and rank than a series. It is most commonly of greatest use in intra-continental classification and correlation, although it has the potential for worldwide recognition. The geochronologic equivalent of a stage is an age.

Chronozone



- **Chronozone.** A chronozone is a nonhierarchical, but commonly small, formal chronostratigraphic unit, and its boundaries may be independent of those ranked chronostratigraphic units such as stage or series.
- Although a chronozone is an isochronous unit, it may be based on a biostratigraphic unit (example: *Cardioceras cordatum* Biochronozone), a lithostratigraphic unit (Woodbend Lithochronozone), or a magnetopolarity unit (Gilbert Reversed-Polarity Chronozone).



- - **Scope.** The scope of the non-hierarchical chronozone may range markedly, depending upon the purpose for which it is defined either formally or informally. The informal “biochronozone of the ammonites,” for example, represents a duration of time which is enormous and exceeds that of a system. In contrast, a biochronozone defined by a species of limited range, such as the *Exus albus* Chronozone, may represent a duration equal to or briefer than that of a stage.



- - **Practical utility.** Chronozones, especially thin and informal biochronozones and lithochronozones bounded by key beds or other “markers,” are the units used most commonly in industry investigations of selected parts of the stratigraphy of economically favorable basins. Such units are useful to define geographic distributions of lithofacies or biofacies, that provide a basis for genetic interpretations and the selection of targets to drill.

Nomenclature



- A formal chronostratigraphic unit is given a compound name, and the initial letters of all words, except for trivial taxonomic terms, are capitalized. Except for chronozone, names proposed for new chronostratigraphic units should not duplicate those for other stratigraphic units.

Stratotypes



- An ideal stratotype for a chronostratigraphic unit is a completely exposed unbroken and continuous sequence of fossiliferous stratified rocks extending from a well-defined lower boundary to the base of the next higher unit. Unfortunately, few available sequences are sufficiently complete to define stages and units of higher rank, which therefore are best defined by boundary-stratotypes.



- **Notes//**

- *system is the primary unit of world-wide major rank; its primacy derives from the history of development of stratigraphic classification.*
- *All systems and units of higher rank are divided completely into units of the next lower rank.*
- *Chronozones are nonhierarchical and commonly lower-rank chronostratigraphic units.*
- *Stages and chronozones in sum do not necessarily equal the units of next higher rank and need not be contiguous.*
- *The rank and magnitude of chronostratigraphic units are related to the time interval represented by the units, rather than to the thickness or areal extent of the rocks on which the units are based.*

Geochronologic Units



- **Geochronologic units:** are divisions of time traditionally distinguished on the basis of the rock record as expressed by chronostratigraphic units. A geochronologic unit is not a stratigraphic unit (i.e., it is not a material unit), but it corresponds to the time span of an established chronostratigraphic unit, and its beginning and ending corresponds to the base and top of the referent.

Ranks and Nomenclature of Geochronologic Units



- The hierarchy of geochronologic units in order of decreasing rank *is eon, era, period, epoch, and age*. Chron is a non-hierarchical, but commonly brief, geochronologic unit.
- Ages in sum do not necessarily equal epochs and need not form a continuum.
- An eon is the time represented by the rocks constituting an eonothem; era by an erathem; period by a system; epoch by a series; age by a stage; and chron by a chronozone.

Diachronic Units



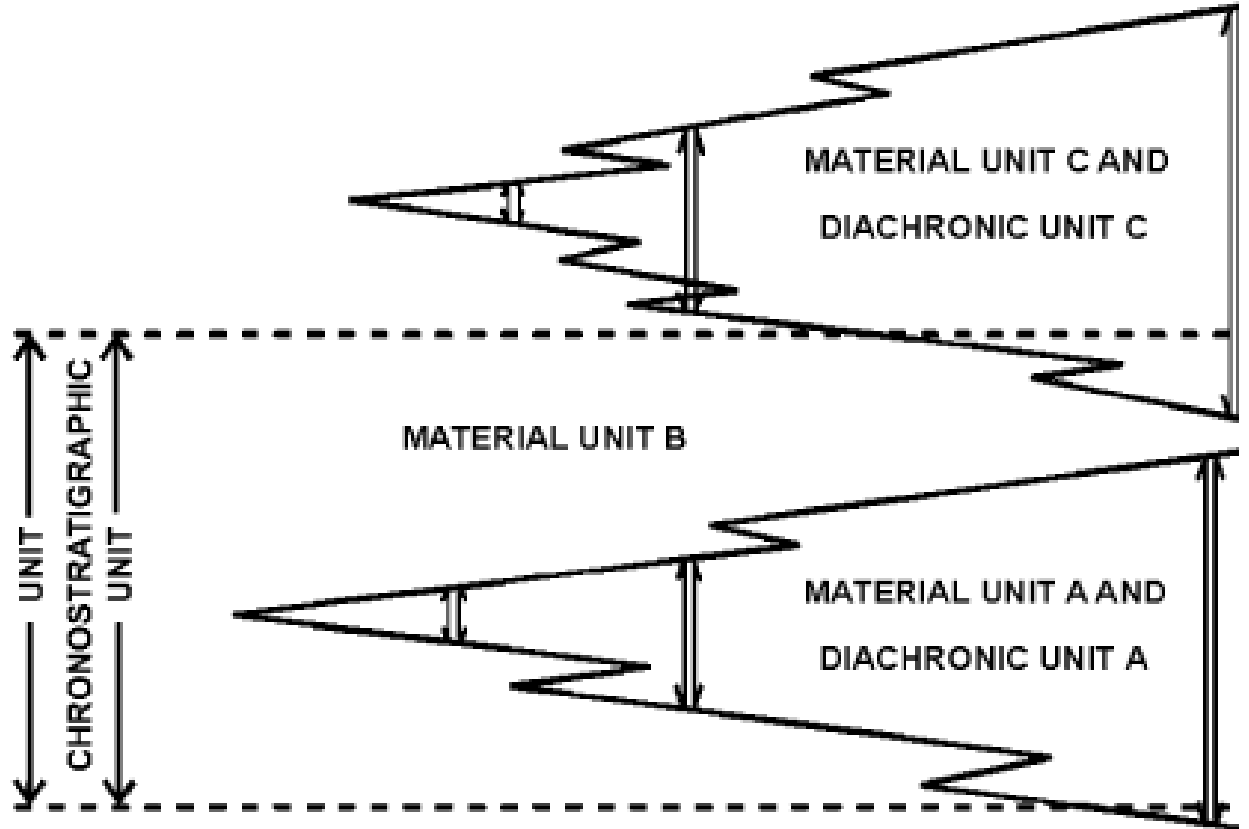
- **Definition.** A diachronic unit comprises the unequal spans of time represented either by a specific lithostratigraphic, allostratigraphic, biostratigraphic, or pedostratigraphic unit, or by an assemblage of such units.
- The scope of a diachronic unit is related to:
 - (1) the relative magnitude of the transgressive division of time represented by the stratigraphic unit or units on which it is based.
 - (2) the areal extent of those units. A diachronic unit is not extended beyond the geographic limits of the stratigraphic unit or units on which it is based.



Boundaries.

The boundaries
of a diachronic

unit are the
times recorded
by the beginning
and end of
deposition of
the material
referent at the
point under
consideration

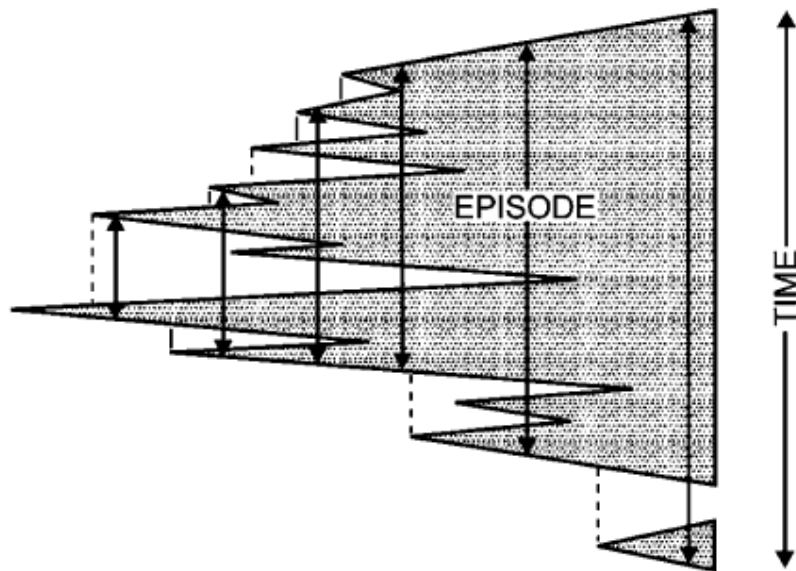


**Comparison of geochronologic,
chronostratigraphic and diachronic units**
(North American Stratigraphic Code. , 2005).

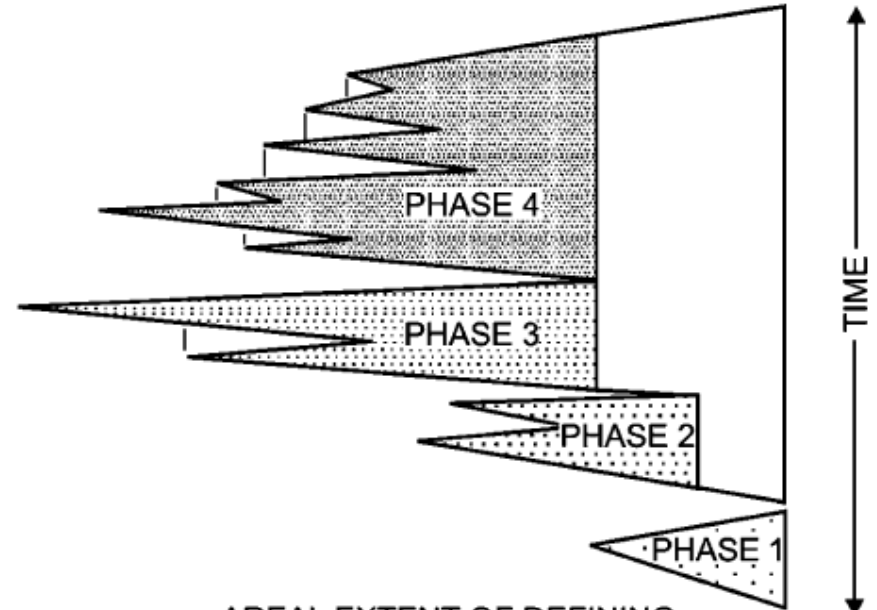
Ranks and Nomenclature of Diachronic Units



- A diachron is the fundamental and non-hierarchical diachronic unit. If a hierarchy of diachronic units is needed, the terms episode, phase, span, and cline, in order of decreasing rank, are recommended. The rank of a hierarchical unit is determined by the scope of the unit, and not by the time span represented by the unit at a particular place.
- **Episode.** An episode is the unit of highest rank and greatest scope in hierarchical classification. If the “Wisconsinan Age” were to be redefined as a diachronic unit, it would have the rank of episode.



AREAL EXTENT OF DEFINING MATERIAL UNIT OR UNITS



AREAL EXTENT OF DEFINING MATERIAL UNIT OR UNITS

Schematic relation of phases to an episode. Parts of a phase may be divided into spans, and spans into clines. Formal definition of spans and clines is unnecessary in most diachronic unit hierarchies (North American Stratigraphic Code. , 2005).



- **Name.** The name for a diachronic unit should be compound, consisting of a geographic name followed by the term diachron or a hierarchical rank term. Both parts of the compound name are capitalized to indicate formal status. If the diachronic unit is defined by a single stratigraphic unit, the geographic name of the unit may be applied to the diachronic unit.

References



- *This lecture is based on the following references:*
- **Brookfield, M.F., 2004.** Principles of Stratigraphy. Blackwell Publishing, 340P.
- **North American Stratigraphic Code. , 2005.** AAPG Bulletin, v. 89, no. 11, pp. 1547–1591.