Introduction to Chronostratigraphy

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Introduction

• Interpreting Earth history is the most important task of any geologist. To interpret Earth history , stratigraphic units needs to be related to geologic time; that is ,the ages of rock units must be known. Establishing the time relationship among rock units is called **Chronostratigraphy** and stratigraphic units defined and delineated on the basis of time are **geologic time units.**

• Classifying rocks on the basis of time involves systematic organization of strata into named units, each corresponding to specific intervals of geologic time. These units provide a basis for **time correlation** and **a reference system** for recording and systematizing specific events in the geologic history of Earth. Thus, the ultimate aim of creating a standardized geologic time scale is to establish a hierarchy of **Chronostratigraphic units** of international scope.

Nature of Chronostratigraphic Units

• **Chronostratigraphic units** are bodies of rocks, layered or unlayered, that were formed during a specified interval of geologic time.

• The units of geologic time during which chronostratigraphic units were formed are called **geochronologic units.**

• **Chronostratigraphic units** are defined as encompassing all rocks formed within certain time spans of Earth history regardless of their compositions or properties.By definition, these units everywhere include rocks of only a certain age and their boundaries are everywhere synchronous. This is in contrast with lithostratigraphic units that can be objectively recognized wherever there are rocks, and with biostratigraphic, magnetostratigraphic polarity, and unconformity-bounded units that are limited by the occurrence of specific properties or attributes of the rocks. Whereas other kinds of stratigraphic units are distinguished, established, and identified on the basis of observable physical features, chronostratigraphic units are distinguished, established, and identified on the basis of their time of formation-an abstract character-as interpreted from these observable properties.

Definitions

• **Chronostratigraphy.** The element of stratigraphy that deals with the relative time relations and ages of rock bodies.

• **Chronostratigraphic classification.** The organization of rocks into units on the basis of their age or time of origin.The purpose of chronostratigraphic classification is to organize systematically the rocks forming the Earth's crust into named units (chronostratigraphic units) corresponding to intervals of geologic time (geochronologic units) to serve as a basis for time-correlation and a reference system for recording events of geologic history.

• **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.

•The rank and relative magnitude of the units in the chronostratigraphic hierarchy are a function of the length of the time interval that their rocks subtend, rather than of their physical thickness.

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

Kinds of Chronostratigraphic Units

The following formal chronostratigraphic terms and geochronologic equivalents to express units of different rank or time scope :

Conventional Hierarchy of Formal Chronostratigraphic and Geochronologic Terms.

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

Cont.

Hierarchy of formal chronostratigraphic and geochronologic unit terms

Position within a chronostratigraphic unit is expressed by adjectives indicative of position such as:basal, lower, middle, upper, etc.; position within a geochronologic unit is expressed by temporal adjectives such as:early, middle, late, etc.

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.

Stage (and Age)

The stage has been called the basic working unit of chronostratigraphy because it is suited in scope and rank to the practical needs and purposes of intraregional chronostratigraphic classification.

a. Definition. The stage includes all rocks formed during an age. A stage is normally the lowest ranking unit in the chronostratigraphic hierarchy that can be recognized on a global scale.It is a subdivision of a series.

b. Boundaries and stratotypes. A stage is defined by its boundary stratotypes, sections that contain a designated point in a stratigraphic sequence of essentially continuous deposition, preferably marine, chosen for its correlation potential.The selection of the boundaries of the stages of the Standard Global Chronostratigraphic Scale deserves particular emphasis because such boundaries serve to define not only the stages but also chronostratigraphic units of higher rank, such as series and systems.

c. Time span. The lower and upper boundary stratotypes of a stage represent specific moments in geologic time, and 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.

d. Name. The name of a stage should be derived from a geographic feature in the vicinity of its stratotype or type area.In English, the adjectival form of the geographic term is used with an ending in "ian" or "an". The age takes the same name as the corresponding stage.

Series (and Epoch)

a. Definition. 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.
b. Boundaries and boundary-stratotypes. Series are defined by boundary stratotypes .
c. Time span. The time span of currently accepted series ranges from 13 to 35 million years.
d. Name. 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 epoch corresponding to a series takes the same name as the series except that the terms "lower" and "upper" applied to a series are changed to "early" and "late" when referring to an epoch.
e. Misuse of"series". The use of the term "series" for a lithostratigraphic unit more or less equivalent to a group should be discontinued.

System (and Period)

a. Definition. 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.

b. Boundaries and boundary-stratotypes. The boundaries of a system are defined by boundary-stratotypes.

c. Time span. 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.

d. Name. The names of currently recognized systems are of diverse origin inherited from early classifications: some indicate chronologic position (Tertiary, Quaternary), others have lithologic connotation (Carboniferous, Cretaceous), others are tribal (Ordovician, Silurian), and still others are geographic (Devonian, Permian).

Likewise, they bear a variety of endings such as "an", "ic", and "ous". There is no need to standardize the derivation or orthography of the well-established system names. The period takes the same name as the system to which it corresponds.

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.

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.

Nonhierarchical formal chronostratigraphic units - the Chronozone

a. Definition. A chronozone is a formal chronostratigraphic unit of unspecified rank, not part of the hierarchy of conventional chronostratigraphic units. 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.

b. Time span. The time span of a chronozone is the time span of a previously designated stratigraphic unit or interval, such as a lithostratigraphic, biostratigraphic, or magnetostratigraphic polarity unit.It should be recognized, however, that while the stratigraphic unit on which the chronozone is based extends geographically only as far as its diagnostic properties can be recognized, the corresponding chronozone includes all rocks formed everywhere during the time span represented by the designated unit. 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 (Figure).

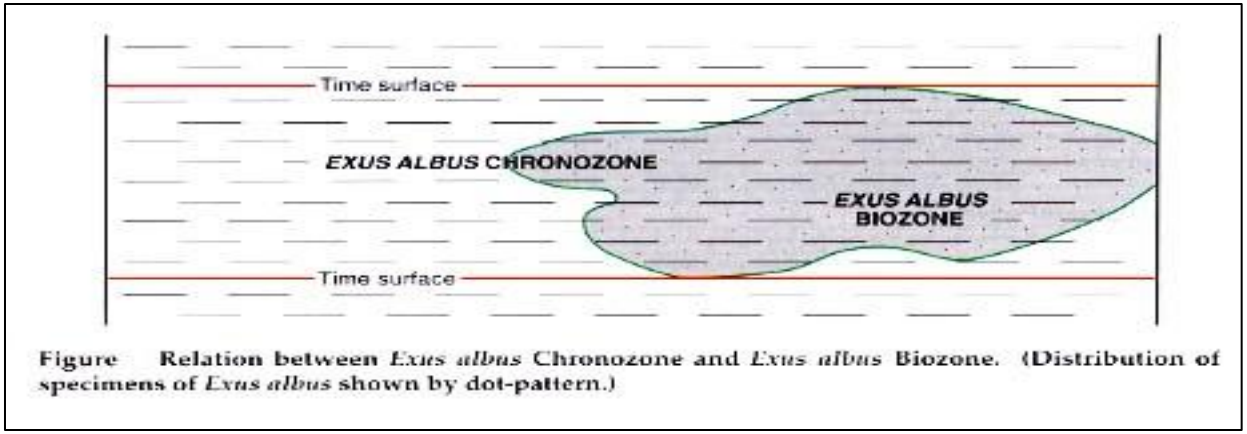

Figure Relation between *Exus albus* Chronozone and *Exus albus* Biozone. (Distribution of specimens of *Exus albus* shown by dot-pattern.)

Nonhierarchical formal chronostratigraphic units - the Chronozone

Chronozones may be of widely different time spans. The designation of the boundaries of a chronozone and of its time span can be done in several ways depending on the nature of the stratigraphic unit on which the chronozone is based.If the unit has a designated stratotype, the boundaries and time span of the chronozone can be made to correspond either to those of the unit at its stratotype or to the total time span of the unit, which may be longer than that at the stratotype.

In this second case, the boundaries and time span of the chronozone would vary with increasing information concerning the time span of the unit.If the unit on which the chronozone is based is of the type which cannot appropriately have a designated stratotype, such as a biostratigraphic unit, its time span cannot be defined either because the time span of the reference unit may change with increasing information .

c. Geographic extent. The geographic extent of a chronozone is, in theory, worldwide, but its pplicability is limited to the area over which its time span can be identified, which is usually less.

d. Name. 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

1. Concept. A major goal of chronostratigraphic classification is the establishment of a hierarchy of chronostratigraphic units of worldwide scope, which will serve as a standard scale of reference for the dating of all rocks everywhere and for relating all rocks everywhere to world geologic history . All units of the standard chronostratigraphic hierarchy are theoretically worldwide in extent, as are their corresponding time spans.

2. Present status. The Standard Global Chronostratigraphic (Geochronologic) Scale can be found in the International Chronostratigraphic Chart.

Regional Chronostratigraphic Scales

The units of the Standard Global Chronostratigraphic (Geochronologic) Scale are valid only as they are based on sound, detailed local and regional stratigraphy.Accordingly, the route toward recognition of uniform global units is by means of local or regional stratigraphic scales. Moreover, regional units will probably always be needed whether or not they can be correlated with the standard global units. It is better to refer strata to local or regional units with accuracy and precision rather than to strain beyond the current limits of time correlation in assigning these strata to units of a global scale. Local or regional chronostratigraphic units are governed by the same rules as are established for the units of the Standard Global Chronostratigraphic Scale.

Procedures for Establishing Chronostratigraphic Units

Boundary stratotypes as standards	**Advantage of defining chronostratigraphic units by their lower boundary stratotypes.**	**Requirements for the selection of boundary stratotypes of chronostratigraphic units.**

1. **Boundary stratotypes as standards.**

- The essential part of the definition of a chronostratigraphic unit is the time span during which the unit described was formed. Since the only record of geologic time and of the events of geologic history lies in the rocks themselves, the best standard for a chronostratigraphic unit is a body of rocks formed between two designated instants of geologic time.For these reasons, the boundaries of a chronostratigraphic unit of any rank are defined by two designated reference points in the rock sequence.
- The two points are located in the boundary-stratotypes of the chronostratigraphic unit which need not be part of a single section.Both, however, should be chosen in sequences of essentially continuous deposition since the reference points for the boundaries should represent points in time as specific as possible.

2. Advantage of defining chronostratigraphic units by their lower boundary stratotypes.

• The definition of a chronostratigraphic unit places emphasis in the selection of the boundary-stratotype of its lower boundary; its upper boundary is defined as the lower boundary of the succeeding unit. This procedure avoids gaps and overlaps in the Standard Global Chronostratigraphic Scale.

• For example, should it be shown that the selected horizon is at the level of an undetected break in the sequence, then the missing span of geologic history would belong to the lower unit by definition and ambiguity is avoided.

3. Requirements for the selection of boundary stratotypes of chronostratigraphic units.

• Chronostratigraphic units offer the best promise of being identified, accepted, and used globally and of being, therefore, the basis for international communication and understanding because they are defined on the basis of their time of formation, a universal property. Particularly important in this respect are the units of the Standard Global Chronostratigraphic (Geochronologic) Scale.

• The term "Global Boundary Stratotype Section and Point" (GSSP) has been proposed for the standard boundary-stratotypes of the units of this scale.

The IUGS International Commission on Stratigraphy is the body responsible for coordinating the selection and approval of GSSPs of the units of the Standard Global Chronostratigraphic (Geochronologic) Scale.

Procedures for Extending Chronostratigraphic Units-Chronocorrelation (Time Correlation)

The boundaries of chronostratigraphic units are synchronous horizons by definition. In practice, the boundaries are synchronous only so far as the resolving power of existing methods of time correlation can prove them to be so.All possible lines of evidence should be utilized to extend chronostratigraphic units and their boundaries. Some of the most commonly used are:

1. **Physical Interrelations of strata.**
2. **Lithology**
3. **Paleontology**
4. **Isotopic age determinations**
5. **Geomagnetic polarity reversals**
6. **Paleoclimatic change**
7. **Paleogeography and eustatic changes in sea level**
8. **Unconformities**
9. **Orogenies**

Naming of Chronostratigraphic Units

A formal chronostratigraphic unit is given a binomial designation - a proper name plus a term-word - and the initial letters of both are capitalized.Its geochronologic equivalent uses the same proper name combined with the equivalent geochronologic term, e.g., Cretaceous System - Cretaceous Period.

References

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THANKS