NORTH AMERICAN COMMISSION ON STRATIGRAPHIC NOMENCLATURE
Report 15 - Revised Articles 2, 61 and 62 of the North American Stratigraphic Code to Formalize Chemostratigraphic Units

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INTRODUCTION

At the 77th Annual Meeting of the North American Commission on Stratigraphic Nomenclature (NACSN), 10 October 2022, Denver, Colorado, the Commission voted to accept the introduction of Chemostratigraphic Units to the North American Stratigraphic Code (NACSN 2021) and revisions to the OVERVIEW section and Articles 2, 61 and 62, the renumbering of Articles 61–97 as Articles 63–99, minor rewording of Articles 68 and 77, and concomitant changes to Tables 1 and 2 and Text-Figure 1. Specific revisions of the Code are indicated in red text. These changes replace all older versions of the specified Articles. An application for this revision (Scott et al. 2020) was published in *Stratigraphy* more than one year prior to the meeting; thus, the vote on this application for revision follows Article 21 of the Code. The numbering of the Articles here differs from that proposed in Scott et al. (2020) hence new versions of Tables 1 and 2 and Text-Figure 1 are introduced here.

These revisions explicitly allow the use of Chemostratigraphic Units in formal stratigraphic nomenclature.

OVERVIEW, CATEGORIES RECOGNIZED

Material Categories Based on Content or Physical Limits

Insert this paragraph following *allostratigraphic units* and before the paragraph on Geologic-Climate units:

Chemical properties, such as isotopes of carbon, oxygen, and strontium, as well as common elements, trace elements, rare earth elements, and total organic content, vary spatially and temporally in stratigraphic successions composed of rock, sediment or ice. Geochemical properties, or combinations of properties, provide the basis for defining and recognizing material units (*Chemostratigraphic Units*, Article 61). Because geochemistry commonly varies with concomitant changes in the ambient environmental conditions or reflects changes in the sediment source area, geochemical changes in the stratigraphic record are important tools for correlation and deciphering Earth history.

PART II. ARTICLES, INTRODUCTION

Article 2. — **Categories**. Categories of formal stratigraphic units, though diverse, are of three classes. The first class (I in Table 1) is of material categories based on content, inherent attributes, or physical limits, and includes lithostratigraphic, lithodemic, magnetopolarity, biostratigraphic, pedostratigraphic, allostratigraphic, and, chemostratigraphic units.

FORMAL UNITS DISTINGUISHED BY CONTENT, PROPERTIES, OR PHYSICAL LIMITS

CHEMOSTRATIGRAPHIC UNITS

Nature and Boundaries

Article 61. — **Nature of Chemostratigraphic Units**. A chemostratigraphic unit is a body of rock, sediment or ice -that is defined or characterized by its specified geochemical properties such as stratigraphic changes in relative proportions of isotopes of carbon, oxygen, and strontium, as well as other common elements, trace elements, rare earth elements, total organic content, or biomarkers. Unit boundaries may be sharp and distinct or gradual. Units may be associated with or bracketed by independent stratigraphic markers such as polarity chronozones, magnetic susceptibility zones, marker beds, or biostratigraphic zones, which aid in their identification.

Remarks. (a) **Definition.** — Chemostratigraphy is the study of the temporal and spatial geochemical variability of the sedimentary record and may establish correlative, mappable rock intervals and facies defined in terms of their characteristic geochemical properties. Changes in relative proportions of isotopes, specific elements, or organic content may show trends of either lower or higher magnitudes. These changes in values characterize parts of the depositional succession and must be syndepositional. These changes in the chemical composition document the timing of changing environmental conditions and thus may become correlation tools between sections and may have chronostratigraphic significance in correlation.

Changes to TABLE 1 (p. 164) –

TABLE 1
Classes of Units Defined.*
I. MATERIAL CATEGORIES BASED ON CONTENT OR PHYSICAL LIMITS

Lithostratigraphic (22)*
Lithodemic (31)**
Magnetopolarity (43)
Biostratigraphic (48)
Pedostratigraphic (55)
Allostratigraphic (58)
Chemostratigraphic (61)

II. CATEGORIES EXPRESSING OR RELATED TO GEOLOGIC AGE

A. Material Categories Used to Define Temporal Spans

Chronostratigraphic (68)
Polarity-Chronostratigraphic (85)

B. Temporal (Non-Material) Categories

Geochronologic (82)
Polarity-Chronologic (88)
Diachronic (93)
Geochronometric (98)

*Numbers in parentheses are the numbers of the Articles where units are defined.
**Italicized categories are those introduced or developed since publication of the previous code (ACSN 1970).

(b) **Contemporaneity of rocks and geochemical signals**. — Geochemical properties of stratified rocks, sediments or ice reflect broad environmental changes in marine, fresh water and estuarine, and terrestrial successions and may result from the chemical composition of water bodies, in which the sediments were deposited, the effect of atmospheric changes, changes in abundance of biotas or accumulation rates of biotic particles, from diagenetic alterations during or after burial, from sedimentary provenance, and/or from weathering processes during subsequent subaerial or submarine exposure. Thus, chemical elements, ions, compounds, or isotopes may be evidence of such processes. Geochemical properties not contemporaneous with the enclosing body of rock, sediment or ice should be avoided in defining, characterizing, or identifying a chemostratigraphic unit.

(c) **Boundaries.** — Boundaries of chemostratigraphic units may be placed at distinctly identifiable, quantifiable changes of geochemical properties that divide the stratigraphic succession into segments based on inflection points, peaks of maximum or minimum values, changes in curve gradient, or by curve shape. Abrupt changes in geochemical composition may also serve to define boundaries. The nature of the boundary must be unambiguously specified at a horizon or interval in a precisely located stratigraphic section (i.e., outcrop or drill core) and by formal definition of the chemozone.

(d) **Reference sections**. — Chemostratigraphic units do not have stratotypes in the sense of Article 3, item (iv), and Article 8 of the Code. -Nevertheless, it is desirable to designate one or more reference sections or a composite section, in which the chemostratigraphic unit is characteristically developed. Reference sections may be either in outcrops or drill cores, and appropriately spaced samples are required. Reference sections should be publicly accessible for future re-sampling to refine sample spacing and/or to test other properties.

Chemostratigraphic Nomenclature

Article 62. — **Fundamental Unit.** A chemozone is the fundamental unit in chemostratigraphic classification. It is the stratigraphic interval whether in rock, sediment or ice characterized by geochemical properties that distinguish the interval from underlying and overlying intervals. The geochemical properties may consist of specific elements, isotope ratios, or ratios of elements or organic content. The measured values may change in a stratigraphic succession resulting in fluctuations, perturbations, shifts, or anomalies.

Remarks. (a) **Ranks.** — Chemozones may be formally subdivided into Subchemozones. Chemozones may be grouped together to form Superchemozones. The rank of a chemostratigraphic unit may be changed when deemed appropriate.

(b) **Thickness and duration.** — The thickness of a chemostratigraphic unit or the amount of time represented by the zone should play no part in the definition of the zone.

(c) **Nomenclature**. —The formal name of a chemostratigraphic unit consists of a geographic name, a proper noun or a mne-

Changes to TABLE 2 (p. 169) –

TABLE 2Categories and Ranks of Units Defined in This Code

I. MATERIAL CATEGORIES BASED ON CONTENT OR PHYSICAL LIMITS

LITHOSTRATIGRAPHIC	LITHODEMIC	MAGNETOPOLARITY	BIOSTRATIGRAPHIC	PEDOSTRATIGRAPHIC	ALLOSTRATIGRAPHIC	CHEMOSTRATIGRAPHIC
Supergroup	Supersuite (Complex)					
Group	Suite	Polarity Superzone			Allogroup	Superchemozone
Formation	*Lithodeme*	*Polarity Zone*	*Biozone* (Interval, Assemblage or Abundance)	*Geosol*	*Alloformation*	*Chemozone*
Member (or Lens, or Tongue)		Polarity Subzone	Subbiozone		Allomember	Subchemozone
Submember						
Bed(s) or Flow(s)						

IIA. MATERIAL CATEGORIES USED TO DEFINE TEMPORAL SPANS

CHRONO-STRATIGRAPHIC	POLARITY CHRONO-STRATIGRAPHIC
Eonothem	Polarity Superchronozone
Erathem (Supersystem)	
System (Subsystem)	*Polarity Chronozone*
Series (Subseries)	
Stage (Substage)	Polarity Subchronozone
Chronozone	

IIB. NON-MATERIAL CATEGORIES RELATED TO GEOLOGIC AGE

GEOCHRONOLOGIC	POLARITY CHRONOLOGIC	DIACHRONIC	GEOCHRONOMETRIC
Eon	Polarity Superchron		Eon
Era (Superperiod)			Era (Superperiod)
Period (Subperiod)	*Polarity Chron*	*Episode*	*Period* (Subperiod)
Epoch (Subepoch)		Phase	Epoch (Subepoch)
Age (Subage)	Polarity Subchron	Span	Age (Subage)
Chron		Cline	Chron

(Diachronic)

monic set of letters with or without numbers, or a succession of numbered geochemical alternations combined with the term "chemozone." A chemozone name may derive from its stratigraphic position. Names typically reflect the discovery history of the corresponding events or phenomena that imprinted the chemostratigraphic signature in the rock record. Subsequent usage of the chemozone and its stratigraphic position should be consistent with the original concept to the extent practical. Formal chemozone names differ from names of bioevents or lithostratigraphic units.

(d) **Events.** — An "event" is a specific geological, environmental, or other phenomenon that occurred in geologic time, even if the details of the cause(s) or the significance and geographic extent of this phenomenon are not known or understood. If the evidence of an event is recorded in the rock or sediment, it may prove useful to name the product of this event. The event process must be clearly distinguished from its rock record. An event is not a stratigraphic unit but is interpreted from the rocks. A chemostratigraphic signal allows the recognition of an event.

The addition of Chemozone requires replacement of Table 1 with Chemostratigraphic (61) inserted below Allostratigraphic (58) and renumbering of subsequent units. Table 2 is revised by adding a Chemostratigraphic column to Part 1. Also, Text-Figure 1 is replaced with Chemostratigraphic inserted below Pedostratigraphic in the column of **Material Referent** below the category of **Formal Units Characterized by Diachroneity**.

The addition of Chemostratigraphic units further requires renumbering subsequent articles and minor changes to Articles 68 and 77:

FORMAL UNITS EXPRESSING OR RELATING TO GEOLOGIC AGE

KINDS OF GEOLOGIC-TIME UNITS

CHRONOSTRATIGRAPHIC UNITS

Nature and Boundaries

Article 68, Remarks.

(c) **Content**. — A chronostratigraphic unit may be bracketed by, be contained within, or overlap with the time span of a biostratigraphic unit, a lithic unit, a magnetopolarity unit, a chemostratigraphic unit, or any other feature of the rock record that has a time range. Or it may be any arbitrary but specified sequence of rocks that has properties allowing chronocorrelation with rock sequences elsewhere.

Article 70. — **Correlation**. No change.

Article 77. — **Chronozone**. A chronozone is a nonhierarchical, but commonly small, formal chronostratigraphic unit, and its boundaries may be independent of such ranked chronostratigraphic units as stage or series. Although a chronozone is an isochronous unit, it may be bracketed by, be contained within or overlap with a biostratigraphic unit (example: *Cardioceras cordatum* Biochronozone), a lithostratigraphic unit (Woodbend

Changes to TEXT-FIGURE 1

FORMAL UNITS DISTINGUISHED BY GEOLOGIC AGE		
	MATERIAL REFERENT	**CORRESPONDING TIME UNIT** (applicable world-wide)
UNITS BASED ON MATERIAL REFERENTS	Chronostratigraphic (68)* Polarity Chronostratigraphic (85)	Geochronologic (82) Polarity Chronologic (90)
UNITS INDEPENDENT OF MATERIAL REFERENTS	None	Geochronometric (98)
FORMAL UNITS DISTINGUISHED BY DIACHRONEITY		
	MATERIAL REFERENT	**CORRESPONDING TIME UNIT** (applicable only where material referent is present)
UNITS BASED ON MATERIAL REFERENTS	Lithostratigraphic (22) Biostratigraphic (48) Allostratigraphic (58) Pedostratigraphic (55) Chemostratigraphic (61)	Diachronic (93)

*Number refers to article number as revised to accommodate 2 new chemostratigraphic articles

TEXT-FIGURE 1
Relation of geologic time units to the kinds of referents on which most are based.
*Number refers to article number as revised to accommodate 2 new chemostratigraphic articles

Lithochronozone), a magnetopolarity unit (Gilbert Reversed-Polarity Chronozone), or a chemostratigraphic unit as a Chemochronozone. Modifiers (litho-, bio-, polarity, chemo-) used in formal names of the units need not be used where the meaning is evident from the context, e.g., *Exus albus* Chronozone.

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REFERENCES

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