Model Report

Geologic Time2

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Table of Contents

GKO-Geologic Time2 diagram

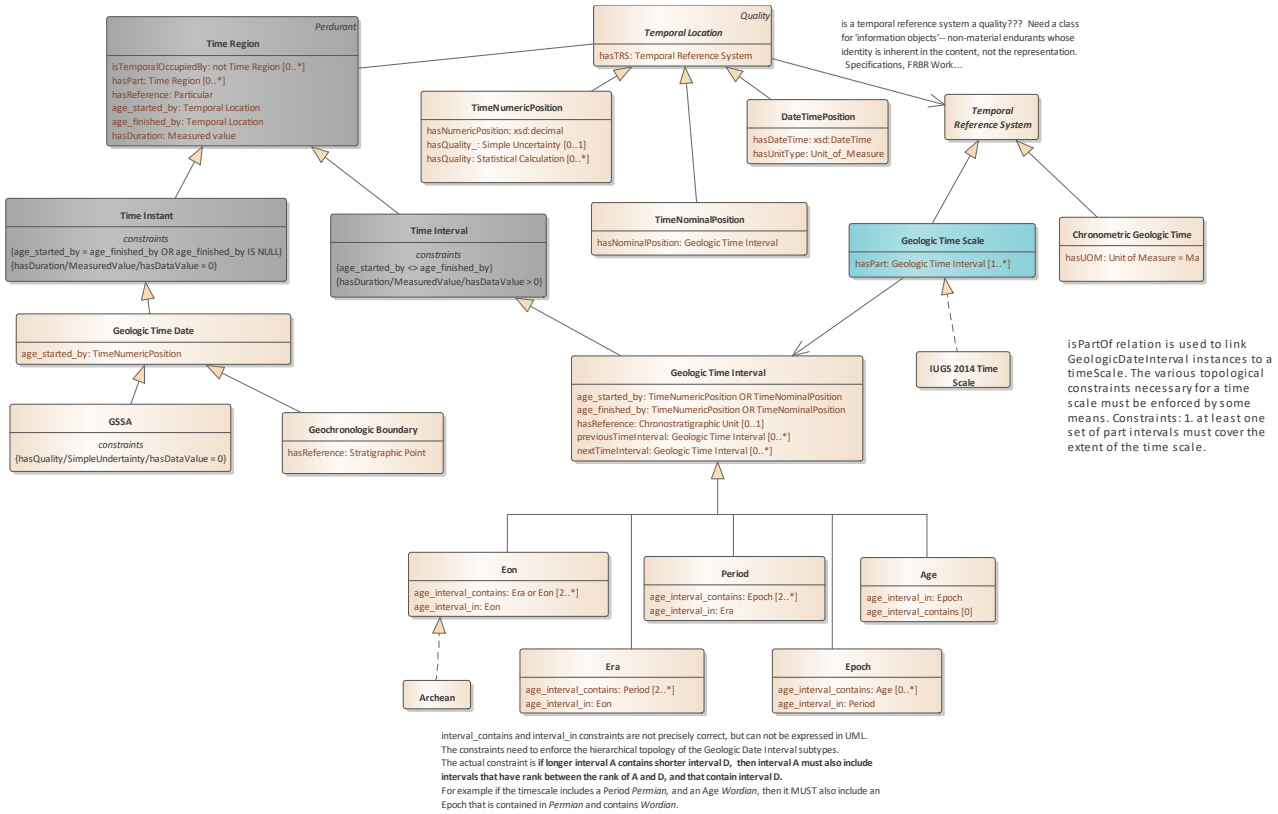

Figure 1: GKO-Geologic Time2

Geologic Time Interval

ATTRIBUTES
age_started_by : TimeNumericPosition OR TimeNominalPosition
age_finished_by : TimeNumericPosition OR TimeNominalPosition
hasReference : Chronostratigraphic Unit Public Multiplicity: ([0..1], Allow duplicates: 0, Is ordered: False)
previousTimeInterval : Geologic Time Interval Public Multiplicity: ([0..*], Allow duplicates: 0, Is ordered: False)
nextTimeInterval : Geologic Time Interval Public Multiplicity: ([0..*], Allow duplicates: 0, Is ordered: False)

ASSOCIATIONS	
Association (direction: Source -> Destination)	
Source: Public (Class) Geologic Time Scale	Target: Public (Class) Geologic Time Interval

Geologic Time Scale

A collection of hierarchical time intervals that cover some Geologic Time Region that is the scope of a Geologic Time Scale (see Cox and Richard, 2014).

INCOMING STRUCTURAL RELATIONSHIPS
Realization from IUGS 2014 Time Scale to Geologic Time Scale

ATTRIBUTES
hasPart : Geologic Time Interval Public Multiplicity: ([1..*], Allow duplicates: 0, Is ordered: False)

IUGS 2014 Time Scale

OUTGOING STRUCTURAL RELATIONSHIPS
Realization from IUGS 2014 Time Scale to Geologic Time Scale

Temporal Location

Quality that specifies the position of a time region relative to some temporal reference system.

ATTRIBUTES
hasTRS : Temporal Reference System Public representation of temporal position in a reference system [iso-19111-2019, iso19108], [ogc-topic-2], i.e. on a number line with a specified origin, such as Julian date, or Unix time, or geologic time. The temporal ordinal reference system should be provided as the value of the :hasTRS property The temporal coordinate system should be provided as the value of the :hasTRS property

ASSOCIATIONS	
Association (direction: Source -> Destination)	
Source: Public (Class) Temporal Location	Target: Public (Class) Temporal Reference System
Association (direction: Unspecified)	
Source: Public (Class) Time Region	Target: Public (Class) Temporal Location

Time Instant

A Time Instant is a Time region that is located by a single temporal location value. DateTimePosition and TimeNominalPosition both assert a 'position' that is actually an interval. The interval represented by a DateTimePosition is determined by the unitType for the position-- a DataTimePosition specified with unitType 'year', e.g. 1950, is the same as an interval from DateTimePosition 1950-01-01 (age_started_by) to 1950-12-31 (age_finished_by). A Geologic age specified as a nominal position 'Cambrian', with TRS <https://stratigraphy.org/icschart/ChronostratChart2020-03> is the same as Time Interval with TimeNumericPosition 541.0 ±1.0 (age_started_by) to 485.4 ±1.9 (age_finished_by)

CONSTRAINTS
Invariant. hasDuration/MeasuredValue/hasDataValue = 0
Invariant. age_started_by = age_finished_by OR age_finished_by IS NULL

Time Interval

A Time Interval is a Time Region that has distinct Temporal Location values for age_started_by and age_finished_by. The validation conditions are complex because of the various ways to specify Temporal Location, but the basic logic is that age_started_by has to be before age_finished_by.

CONSTRAINTS
Invariant. hasDuration/MeasuredValue/hasDataValue > 0
Invariant. age_started_by <> age_finished_by

Time Region

Analogous to TimeInterval in *Time Ontology in OWL, W3C Candidate Recommendation* 26 March 2020: https://www.w3.org/TR/2020/CR-owl-time-20200326/.

Uses idea that time intervals are the more general case and time instants are just a limited specialization (Allen, 1984 http://dx.doi.org/10.1016/0004-3702%2884%2990008-0, Allen and Ferguson,1997 URL: http://dx.doi.org/10.1007/978-0-585-28322-7_7)

ATTRIBUTES

- isTemporalOccupiedBy : not Time Region Public
  Multiplicity: ([0..*], Allow duplicates: 0, Is ordered: False)
- hasPart : Time Region Public
  Multiplicity: ([0..*], Allow duplicates: 0, Is ordered: False)
- hasReference : Particular Public
- age_started_by : Temporal Location Public
- age_finished_by : Temporal Location Public
- hasDuration : Measured value Public

Measurement of duration needs a clock. In its most general form a clock is just a regularly repeating physical event ('tick') and a counting mechanism for the 'ticks'. These counts may be used to logically relate two events and to calculate a duration between the events.

ASSOCIATIONS

Association (direction: Unspecified)
Source: Public (Class) Time Region — Target: Public (Class) Temporal Location

Chronometric Geologic Time

1D coordinate system containing a time axis measuring millions of (Julian) years [Ma], backwards in time from 1950. http://www.opengis.net/def/crs/OGC/0/ChronometricGeologicTime

ATTRIBUTES

- hasUOM : Unit of Measure Public = Ma

DateTimePosition

a time position has a finite extent, corresponding to the precision or temporal unit used. Thus, a DateTimePosition has a duration corresponding to the value of its unitType.

ATTRIBUTES

- hasDateTime : xsd:DateTime Public
- hasUnitType : Unit_of_Measure Public

Geochronologic Boundary

A temporal position that is anchored to a specific location in a stratotype stratigraphic section. Serves as a temporal boundary between two Geochronologic Time Intervals.

OUTGOING STRUCTURAL RELATIONSHIPS

- Generalization from Geochronologic Boundary to Geologic Time Date

ATTRIBUTES

- hasReference : Stratigraphic Point Public

this objectProperty links a Geochronologic Boundary, a temporal position == Geologic Time Date in this model to a Stratigraphic Point that is the mani

ASSOCIATIONS

Association (direction: Unspecified)
Source: Public hasOlderBound (Class) Geochronologic Boundary — Target: Public nextTimeInterval (Class) Geologic Date Interval
Cardinality: [0..*]

Association (direction: Unspecified)
Source: Public hasYoungerBound (Class) Geochronologic — Target: Public previousTimeInterval (Class)

ASSOCIATIONS	
Boundary	Geologic Date Interval Cardinality: [0..*]

Geologic Age

A geologic Property used to specify the age date associated with some geologic entity. Can be quantified as a Chronostratigraphic Age, Geochronologic Age, or a GEochronologic Age Date.

Geologic Age Interval

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Geologic Age Interval to Geologic Time Interval

ATTRIBUTES
hasYoungerInterval : Geologic Date Interval Public
hasOlderInterval : Geologic Date Interval Public

Geologic Date Interval

A time interval that is defined with reference to particular geologic feature in the Earth. Corresponds to GeochronologicEra of Cox and Richard (2014, DOI: 10.1007/s12145-014-0170-6) (gts). The isRealizedBy property corresponds to the manifestedBy property in gts (see http://resource.geosciml.org/vocabulary/timescale/isc2017 for implementation). gts models a stratotype property from GeochronologicEra (the time interval) directly to a Stratotype. In this model the association is indirect from era (time interval) to ChronostratigraphicUnit to Stratotype.

A Geochronologic Time Interval restricts a Geologic Time Interval by restricting the bounding dates to be Geochronologic Boundary.

ATTRIBUTES
hasYoungerDate : Time Instant Public sameAs gts:end
hasOlderDate : Time Instant Public sameAs gts:start

ASSOCIATIONS	
Association (direction: Unspecified) Source: Public hasOlderBound (Class) Geochronologic Boundary	Target: Public nextTimeInterval (Class) Geologic Date Interval Cardinality: [0..*]
Association (direction: Unspecified) Source: Public hasYoungerBound (Class) Geochronologic Boundary	Target: Public previousTimeInterval (Class) Geologic Date Interval Cardinality: [0..*]

Geologic Time Date

A temporal coordinate value, located either by a point position (with uncertainty) on a time line, specified by a numeric coordinate (generally MYPB, but definitions of 'present' vary), or a GeochronologicBoundary if it is associated with a location in a particular stratigraphic section, or a GSSA if the numeric time coordinate is arbitrarily assigned. Probably should specify a Temporal Reference System used to assign coordinate values.

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Geologic Time Date to Time Instant

INCOMING STRUCTURAL RELATIONSHIPS
Generalization from Geochronologic Boundary to Geologic Time Date
Generalization from GSSA to Geologic Time Date

ATTRIBUTES
age_started_by : TimeNumericPosition Public

Geologic Time Interval

ATTRIBUTES
hasReference : Chronostratigraphic Unit Public Multiplicity: ([0..1], Allow duplicates: 0, Is ordered: False)
previousTimeInterval : Geologic Time Interval Public Multiplicity: ([0..*], Allow duplicates: 0, Is ordered: False)
nextTimeInterval : Geologic Time Interval Public Multiplicity: ([0..*], Allow duplicates: 0, Is ordered: False)

Geologic Time Scale

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INCOMING STRUCTURAL RELATIONSHIPS
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ATTRIBUTES
hasPart : Geologic Date Interval Public Multiplicity: ([1..*], Allow duplicates: 0, Is ordered: False)

GSSA

Global Standard Stratigraphic Age, abbreviated GSSA, is a temporal position defined by the International Stratigraphic Commission to define the boundary between Geochronologic Eras in cases where a GSSP (Global Stratigraphic Section and Point) can not be established as a reference for geochronologic boundaries. This is the case for Precambrian rocks older than Ediacaran, for which biostratigraphic evidence is not available and well preserved stratigraphic sections are rare.

CONSTRAINTS
Invariant. hasQuality/SimpleUndertainty/hasDataValue = 0

IUGS 2014 Time Scale

OUTGOING STRUCTURAL RELATIONSHIPS
Realization from IUGS 2014 Time Scale to Geologic Time Scale

Temporal Reference System

A temporal reference system, such as a temporal coordinate reference system (with an origin, direction, and scale), a calendar-clock combination, or a (possibly hierarchical) ordinal system
Note that an ordinal temporal reference system, such as the geologic timescale, may be represented directly, using this ontology, as a set of :ProperIntervals, along with enough inter-relationships to support the necessary ordering relationships. See example below of Geologic Timescale.

ASSOCIATIONS	
Association (direction: Source -> Destination)	
Source: Public (Class) Temporal Location	Target: Public (Class) Temporal Reference System

TimeNominalPosition

a value that identifies a location within an ordinal reference system, by name or URI

ATTRIBUTES
hasNominalPosition : Geologic Time Interval

TimeNumericPosition

A temporal location specified by a numeric coordinate value relative to some temporal reference system.

ATTRIBUTES
hasNumericPosition : xsd:decimal
hasQuality_ : Simple Uncertainty Public Multiplicity: ([0..1], Allow duplicates: 0, Is ordered: False)
hasQuality : Statistical Calculation Public Multiplicity: ([0..*], Allow duplicates: 0, Is ordered: False) for expressing statistics on quality, uncertainty.

NOTES

- is a temporal reference system a quality??? Need a class for 'information objects'-- non-material endurants whose identity is inherent in the content, not the representation. Specifications, FRBR Work...
- isPartOf relation is used to link GeologicDateInterval instances to a timeScale. The various topological constraints necessary for a time scale must be enforced by some means. Constraints: 1. at least one set of part intervals must cover the extent of the time scale.
- interval_contains and interval_in constraints are not precisely correct, but can not be expressed in UML. The constraints need to enforce the hierarchical topology of the Geologic Date Interval subtypes.
- The actual constraint is if longer interval A contains shorter interval D, then interval A must also include intervals that have rank between the rank of A and D, and that contain interval D.
- For example if the timescale includes a Period *Permian*, and an Age *Wordian*, then it MUST also include an Epoch that is contained in *Permian* and contains *Wordian*.