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Conference Abstract

Semantic Mapping of the Geologic Time Scale: A temporal reference

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Abstract

The Geologic Time Scale is an ordered hierarchical set of terms representing specific time intervals in Earth's history. The hierarchical structure is correlated to the geologic record and major geologic events in Earth's history (Gradstein et al. 2020). In the absence of quantitative numeric age values from absolute dating methods, the relative time intervals in the geologic time scale provide us with the vocabulary needed for deciphering Earth's history and chronological reconstruction. This temporal frame of reference is critical to establishing correlations between specimens and how they fit within the Earth's 4.567 Ga (giga annum) history.

Due to spatial and temporal variations in the stratigraphic record, the terminology used in conjunction with geologic time scales is largely inconsistent. For a detailed discussion regarding term use in geologic timescales, see Cohen et al. (2013). As a result, published values for geologic timescale terms are often ambiguous and highly variable, limiting interoperability and hindering temporal correlations among specimens. A solution is to map verbatim geologic timescale values to a controlled vocabulary, constructing a single temporal frame of reference. The harmonization process is governed by an established set of business rules that can ultimately become fully or partially automated.

In this study, we examined the Global Biodiversity Information Facility's (GBIF) published distinct verbatim values for Darwin Core terms in the GeologicalContext Class of Darwin Core to assess the the use of chronostratiphic terms, a process highlighted in Sahdev et al.

(2017). Preservation of these verbatim values, the initial unmapped set of published values, is important. Many are derived directly from primary source material and possess special historical and regional significance. These include land mammal ages (e.g., Lindsay (2003)), biostratigraphic zones, regional terms, and terms with higher granularity than the International Commission of Stratigraphy's (ICS) timescale allows (e.g., subages/substages). For the purposes of this study, we selected the 2023/6 version of the ICS chronostratigraphic timescale as the controlled vocabulary (Cohen et al. 2023). The ICS is the most widely adopted timescale, comprising the most generalized and universally applicable intervals of geologic time.

After semantic analysis of the verbatim values (see Table 1 for comparative statistics), we established a comprehensive set of business rules to map to the ICS timescale controlled vocabulary. This process yielded a collection of documented procedures to transform the heterogeneous collection of published terms into a semantically consistent dataset. The end result is a single temporal frame of reference for published geologic and paleontological specimens through semantic mapping to improve the temporal correlations between geologic specimens globally through data interoperability. This talk will highlight the process of harmonizing a heterogeneous collection of published verbatim Geologic Time Scale values with an established controlled vocabulary through semantic mapping.

Table 1.

The verbatim values table (top) contains the number of unique values for each Darwin Core (dwc) term in the original data set. The ICS (gts) terms table (bottom) contains the number of terms by rank in the ICS timescale. These tables provide a quantitative illustration of the high variability in the original data and the scale of the mapping process where, for example, 4,029 verbatim values assigned to the Age rank were mapped to 101 possible terms in the controlled vocabulary. See Table 2 for namespace usage.

Value Counts	
Term	**Counts**
dwc:earliestEonOrLowestEonothem	245
dwc:latestEonOrHighestEonothem	19
dwc:earliestEraOrLowestErathem	122
dwc:latestEraOrHighestErathem	115
dwc:earliestPeriodOrLowestSystem	515
dwc:latestPeriodOrHighestSystem	153
dwc:earliestEpochOrLowestSeries	1023
dwc:latestEpochOrHighestSeries	529
dwc:earliestAgeOrLowestStage	2690
dwc:latestAgeOrHighestStage	1339

Value Counts	
Term	**Counts**
gts:Super-Eon	1
gts:Eon	4
gts:Era	10
gts:Sub-period	2
gts:Epoch	38
gts:Age	101

Table 2.
Namespaces

dwc	Darwin Core	http://rs.tdwg.org/dwc/terms/
gts	Geologic Timescale model	http://resource.geosciml.org/ontology/timescale/gts

Keywords

controlled vocabularies, stratigraphic record, Darwin Core, geological context, semantic mapping

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Conflicts of interest

The authors have declared that no competing interests exist.

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