GeoScience Ontology (GSO)

For the Loop3D Project

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Author: Boyan Brodaric, GSC
Stephen Richard, USGIN

EA Repository : E:\GitHub\Loop3DGKM\GSO-20200301.eapx

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Introduction

The Loop3D Geoscience Ontology is intended to enable implementation of a 3-D geologic data system in a linked data environment that can be integrated with other national and global environmental and geoscience information systems. The model was initally developed as a conceptual model in UML using the Sparx Enterprise Architect tool, and then implemented in OWL using RDF editing tools. Continuing development of the model has been an iterative process of developing example data documents, and updating the conceptual model and OWL implementation based on the testing and continued model refinement. This document represents the current state of the conceptual model using UML notation.

The geologic scope of the model includes Earth Materials, Geologic Units, and Geologic Structure, and Geologic Relationships. The UML is modularized with packages representing 1) high-level cross domain concepts ('Top'), 2) Geologic Materials ('Amount of Matter'); 3) Processes ('Geologic Process'); 4) Rock Bodies, including Geologic Units ('Geologic Rock Body'); 5) 'Geologic Setting'; 6) 'Geologic Structure'; and 7) 'Geologic Time'. The UML packaging broadly parallels the modularization in the OWL implementation, but the OWL implementation modules are more granular to enable development of application-specific profiles that bring a minimum of unneeded classes and properties. The top-level ontology framework is adapted from DOLCE with some BFO modifications. The basic Geology framework is based on previous models, including the NADM C1 model (https://pubs.usgs.gov/of/2004/1334/) and the GeoSciML v3.2 (http://geosciml.org/doc/geosciml/3.2/documentation/html/) conceptual model.

This document consists of Diagrams section that includes the UML diagrams for the model, and a Classes section that contains descriptions of the model classes, their properties and relationships, based on scope notes in the UML model document. Improvement of the documentation will be an ongoing process.

Diagrams

Top

This package includes Classes imported from DOLCE or other high-level ontologies. They are used to establish the conceptual framework for the geology ontology. Definitions are not in general included in this model, the user should refer to literature on DOLCE, e.g. S Borgo, C Masolo, 2009, Foundational choices in DOLCE, R. Poli et al. (eds.), Theory and Applications of Ontology: Computer Applications, DOI 10.1007/978-90-481-8847-5_13, Springer Science+Business Media B.V.
Classes are implement in OWL in GSO-Common.ttl

GSO-Top diagram

Class diagram in package 'Top'

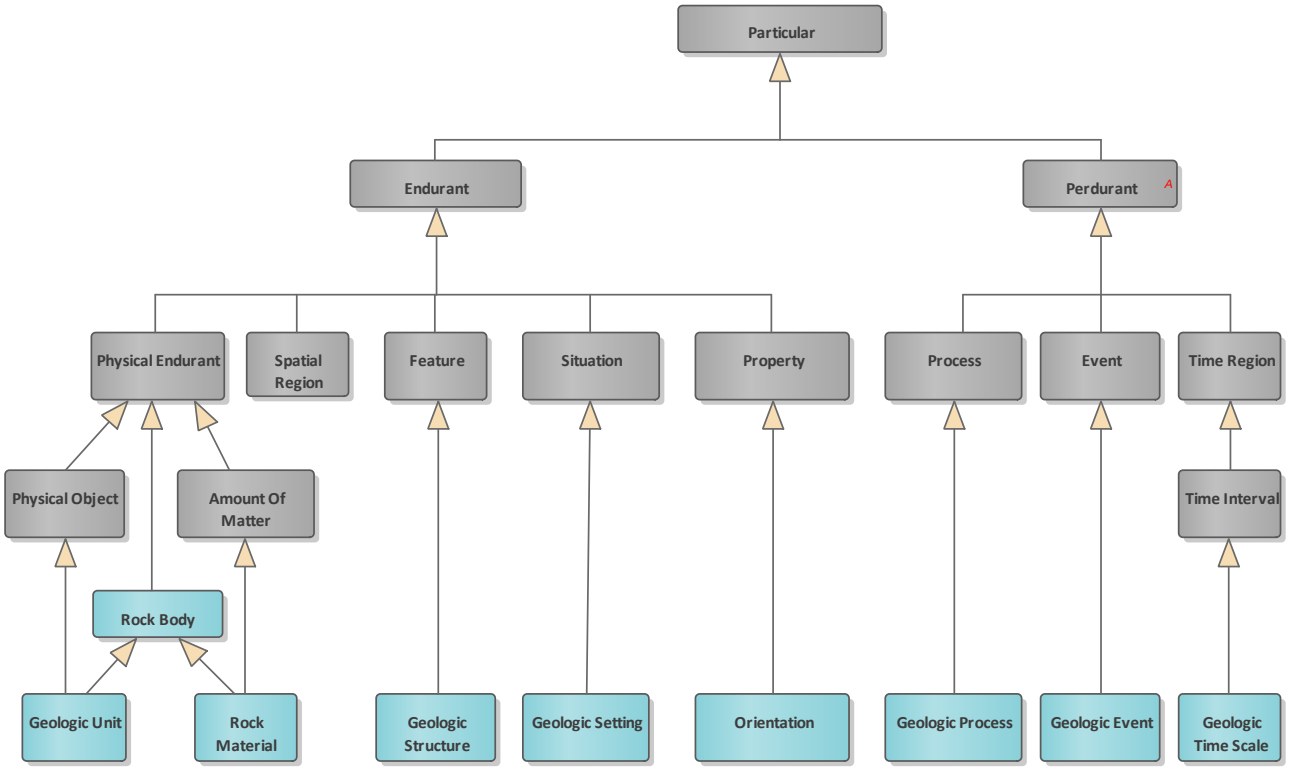

Figure 1: GSO-Top

GSO-Endurant diagram

Class diagram in package 'Top'

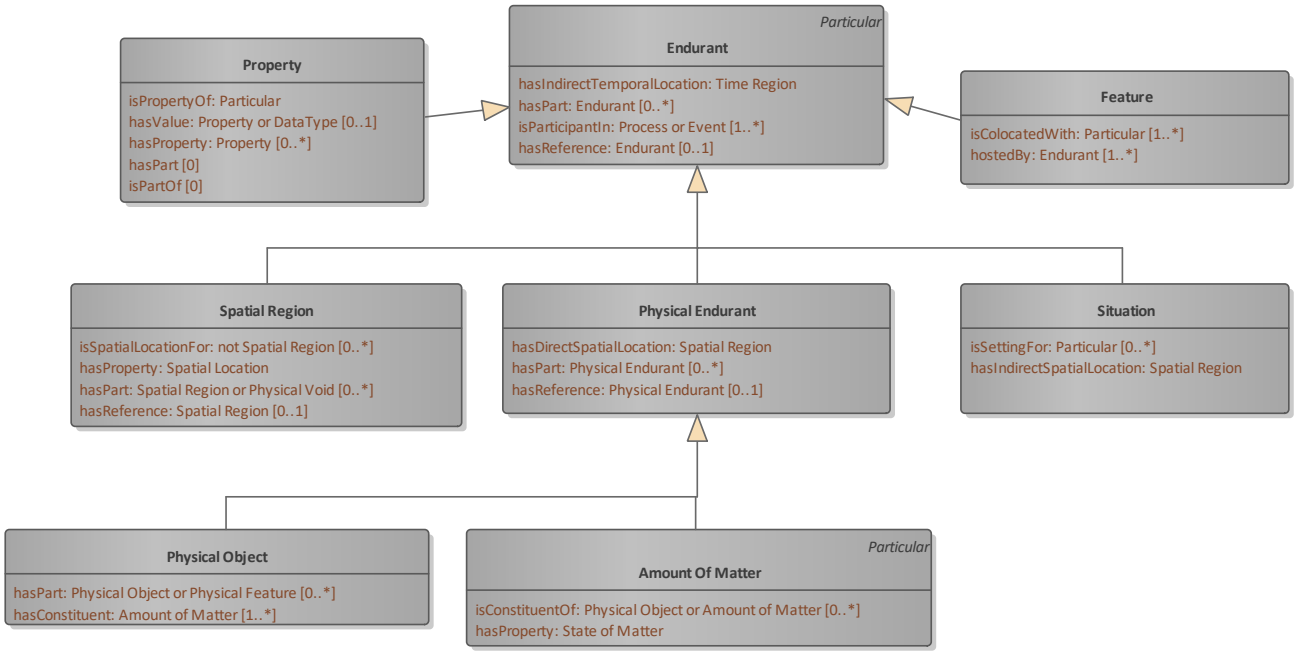

Figure 2: GSO-Endurant

GSO-Perdurant diagram

Class diagram in package 'Top'

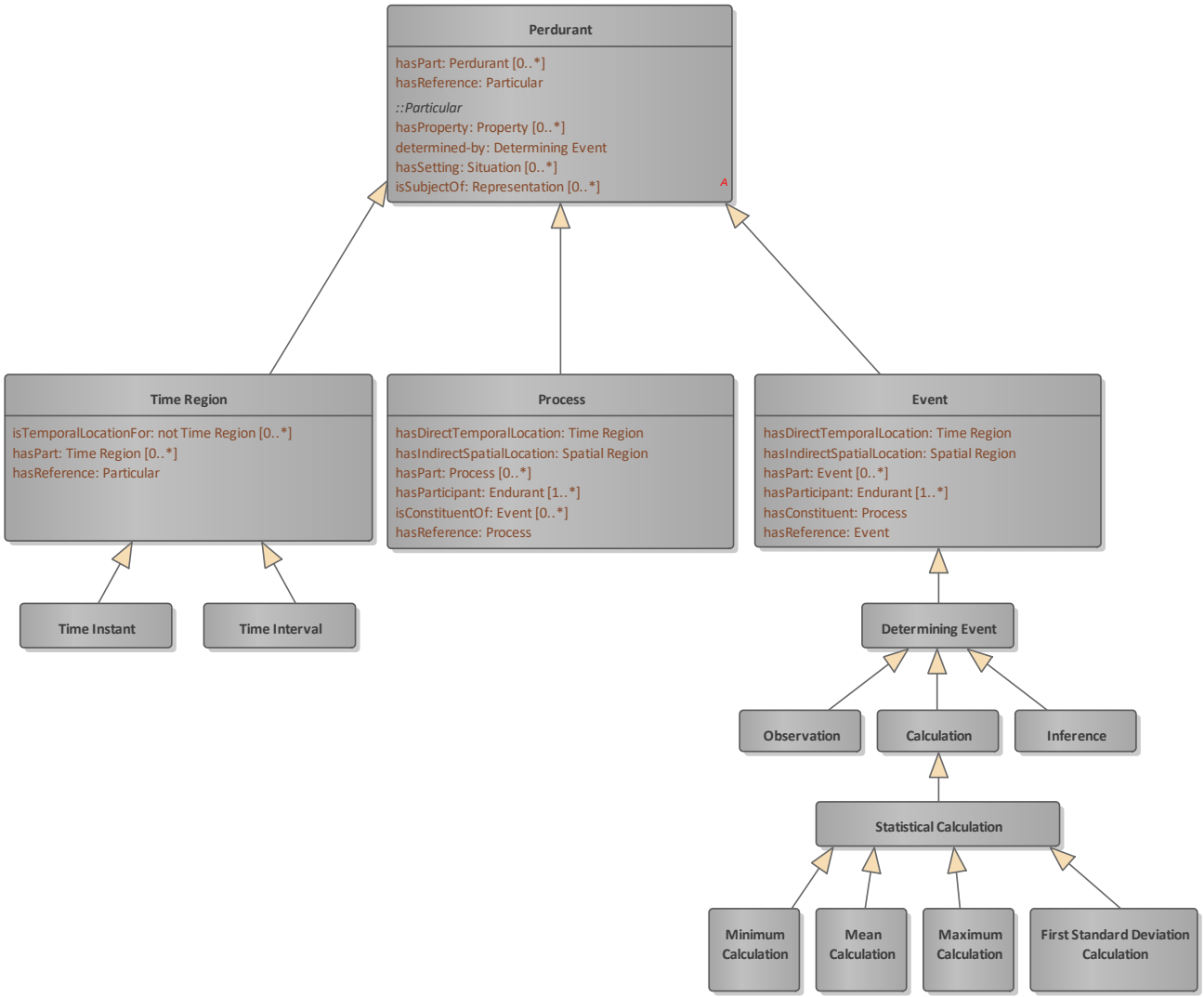

Figure 3: GSO-Perdurant

GSO-Property diagram

Class diagram in package 'Top'

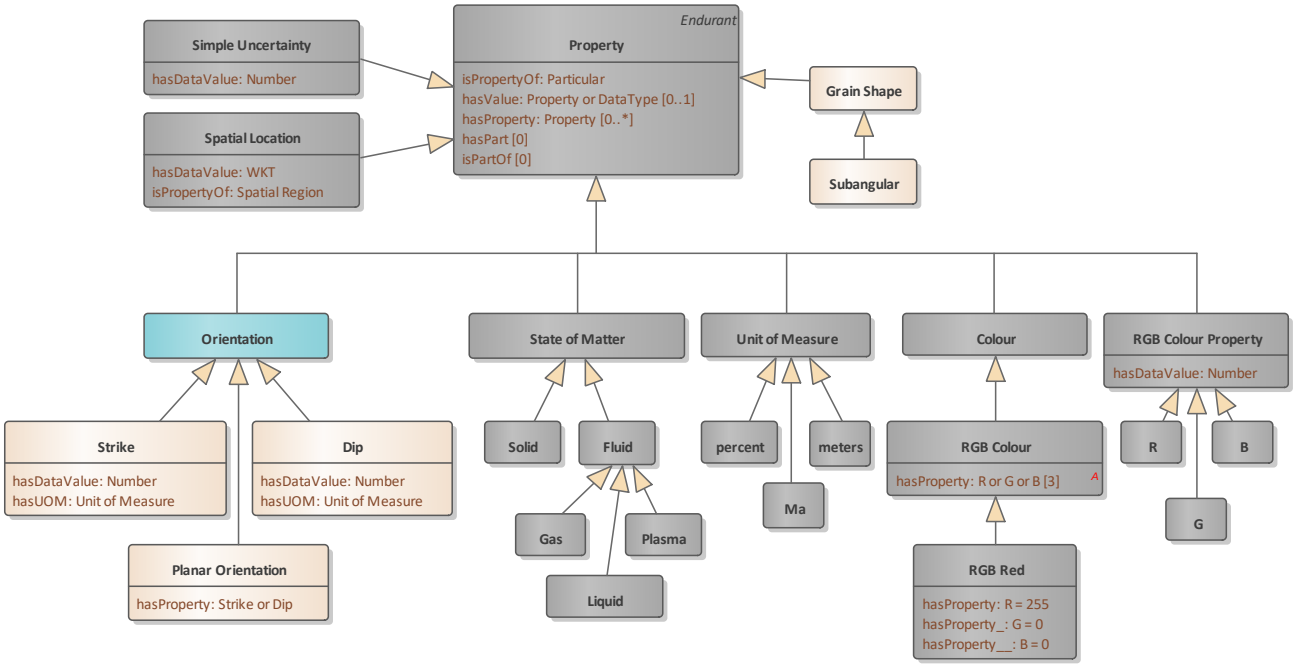

Figure 4: GSO-Property

GSO-Feature diagram

Class diagram in package 'Geologic Structure'

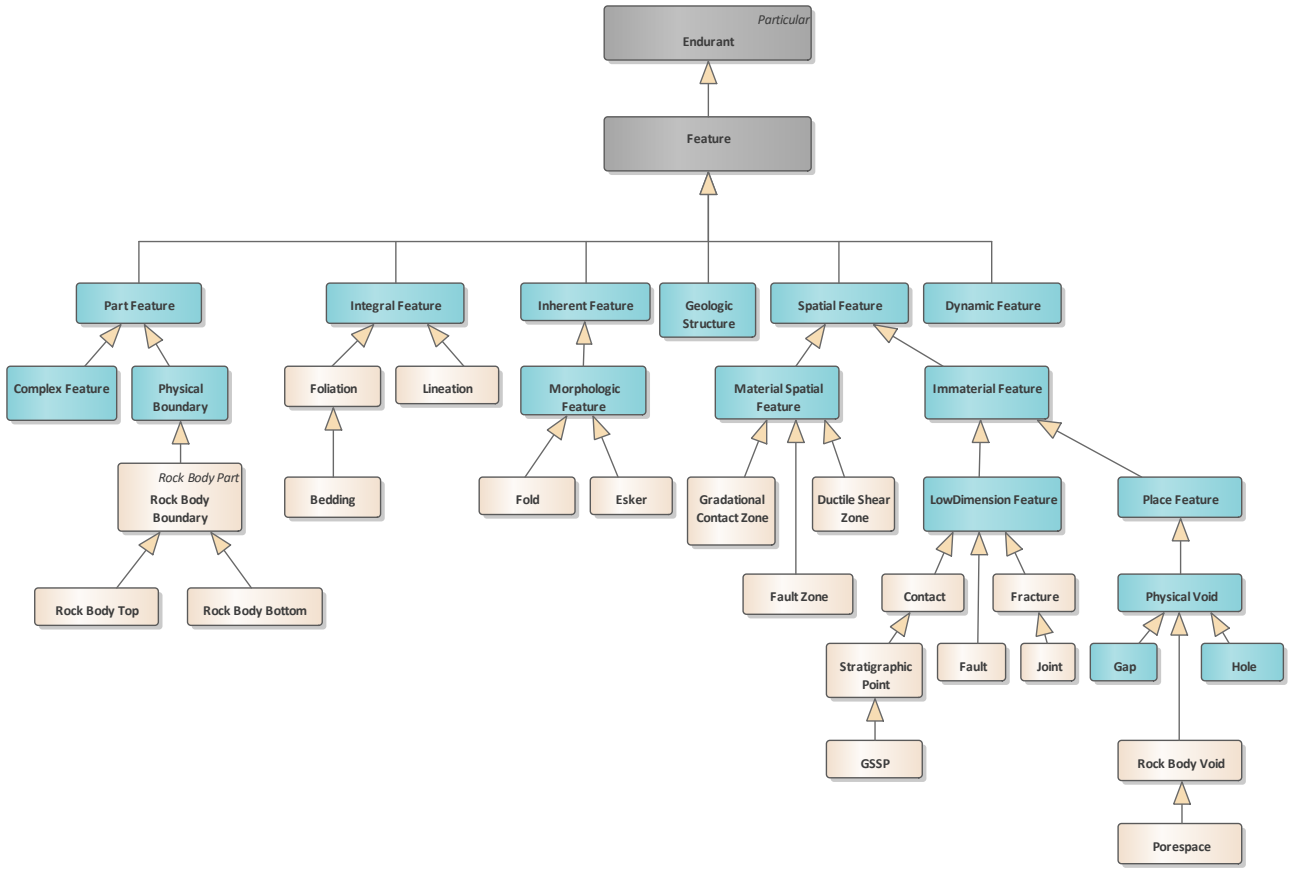

Figure 5: GSO-Feature

Geologic Time

GSO-Geologic Time diagram

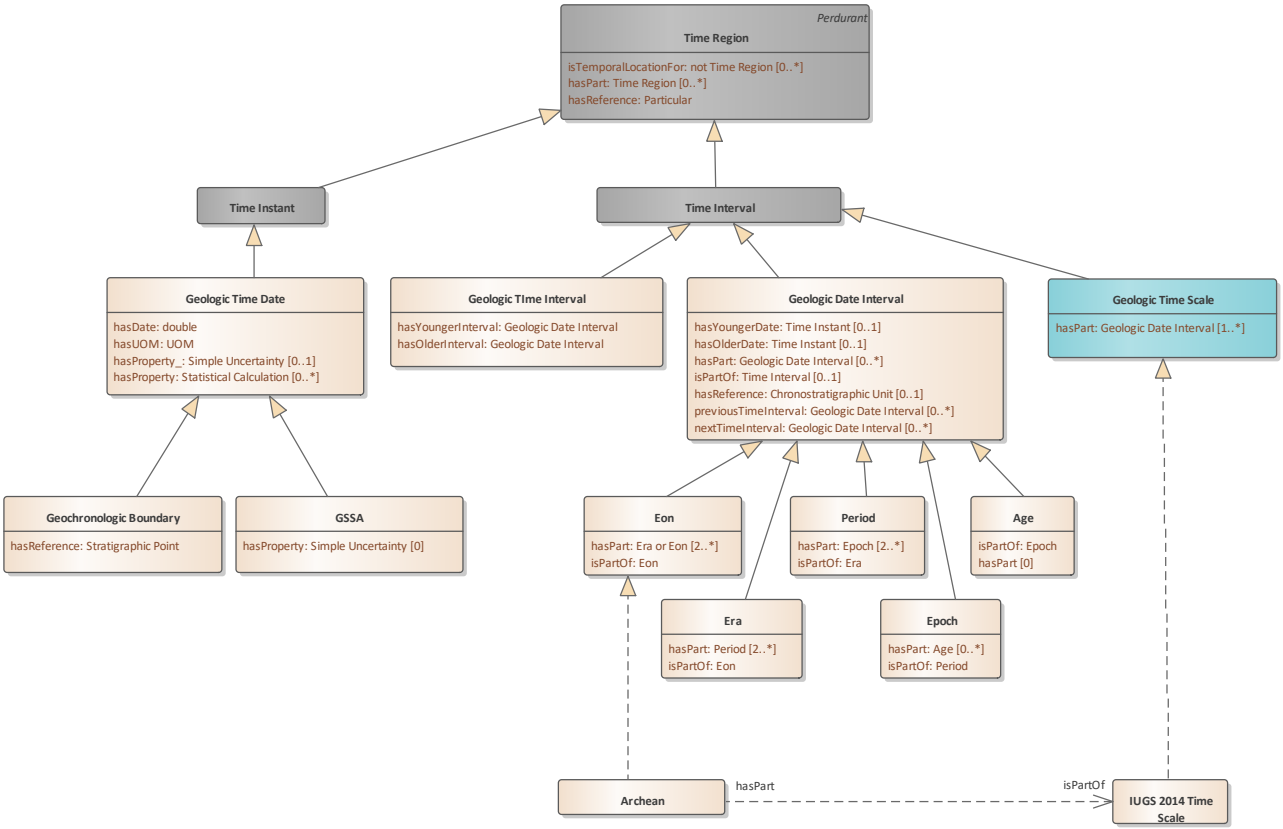

Figure 6: GSO-Geologic Time

Amount of Matter

Amount of Matter diagram

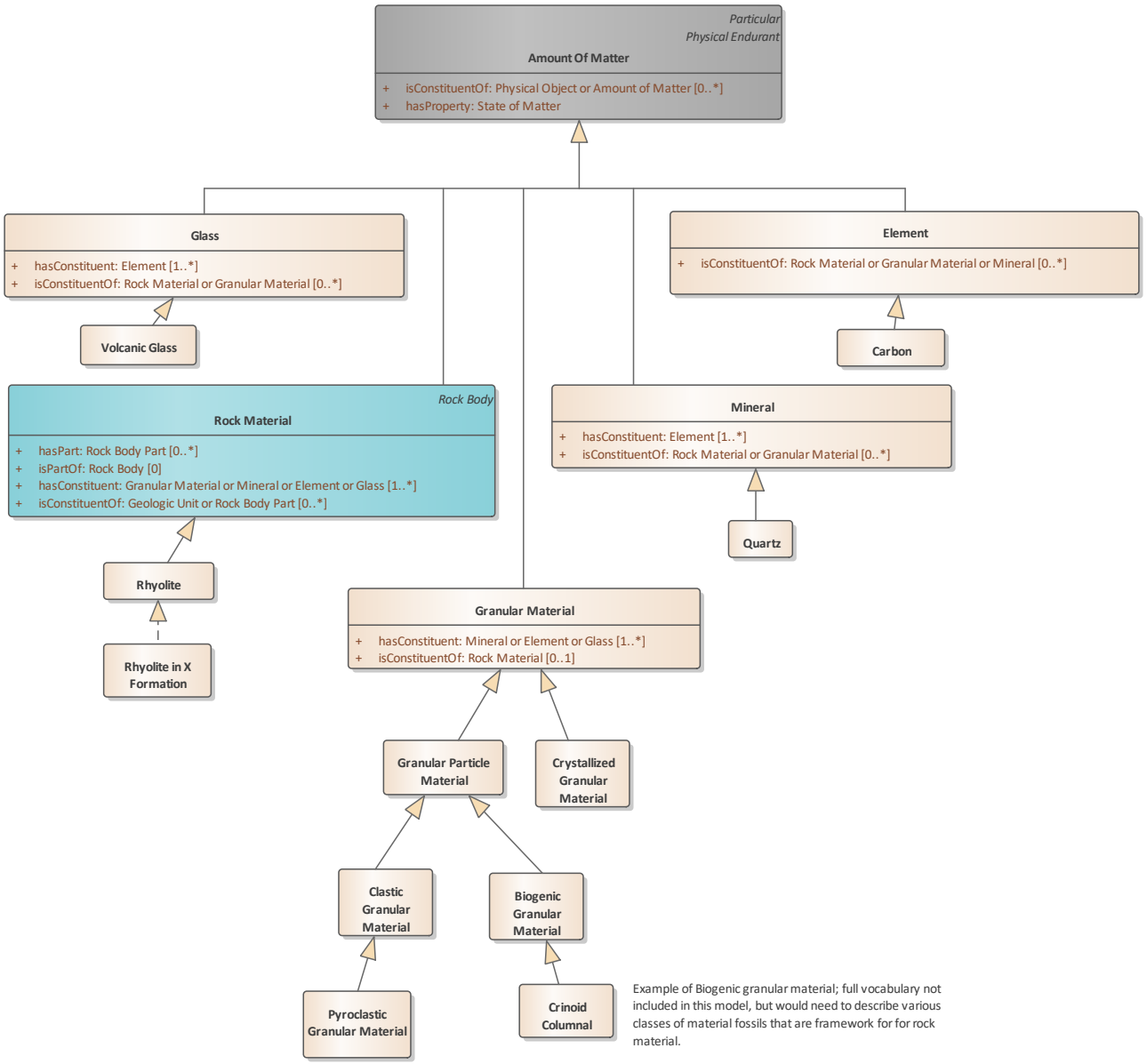

Figure 7: GSO-Amount of Matter

Geologic Process

GSO-Geologic Process diagram

Class diagram in package 'Geologic Process'
A perdurant is an entity that only exists partially at any given point in time.

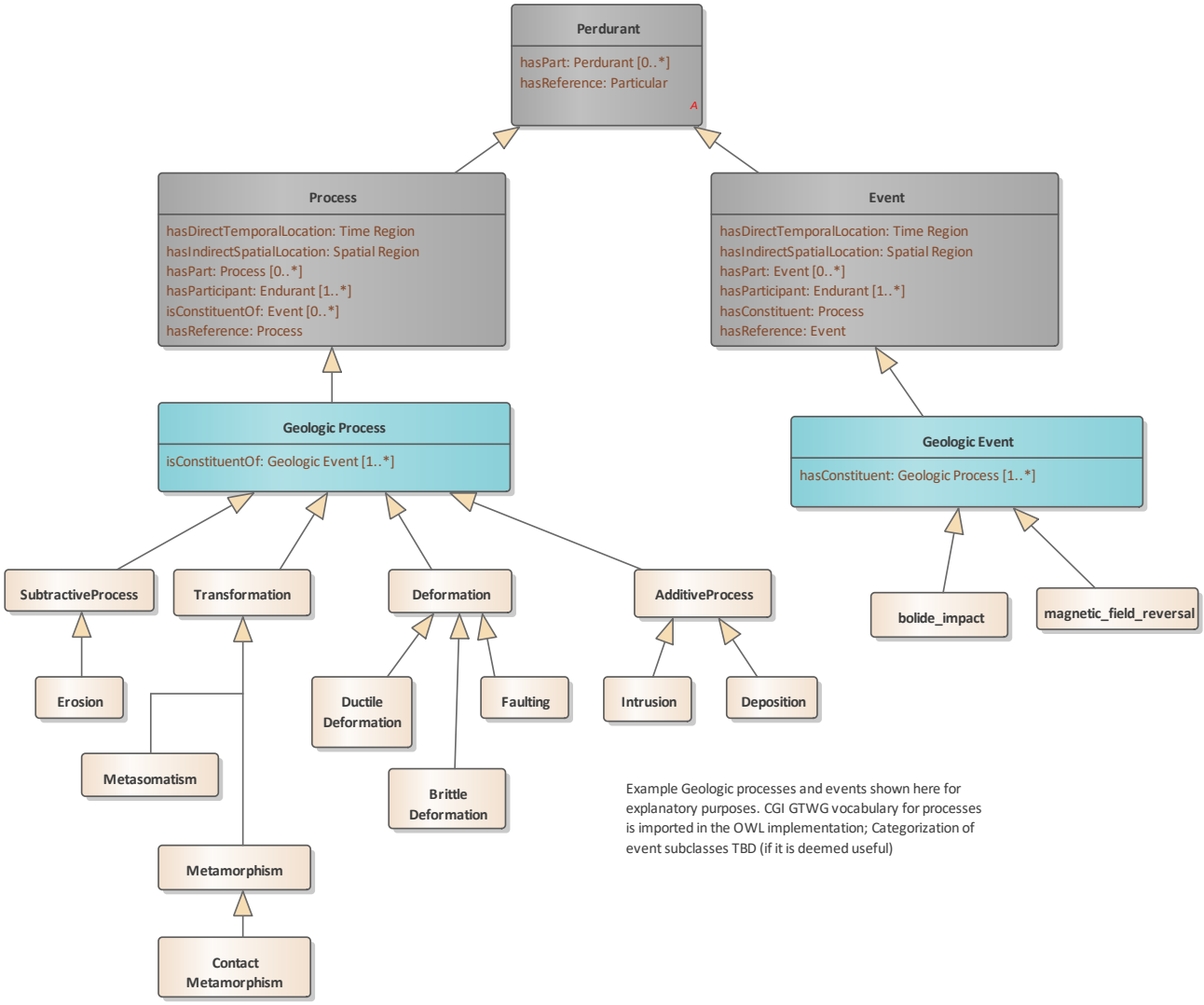

Figure 8: GSO-Geologic Process

Geologic Rock Body

GSO-Rock Body diagram

Class diagram in package 'Geologic Rock Body'
A rock body part that is a fragment of a pre-existing rock body.

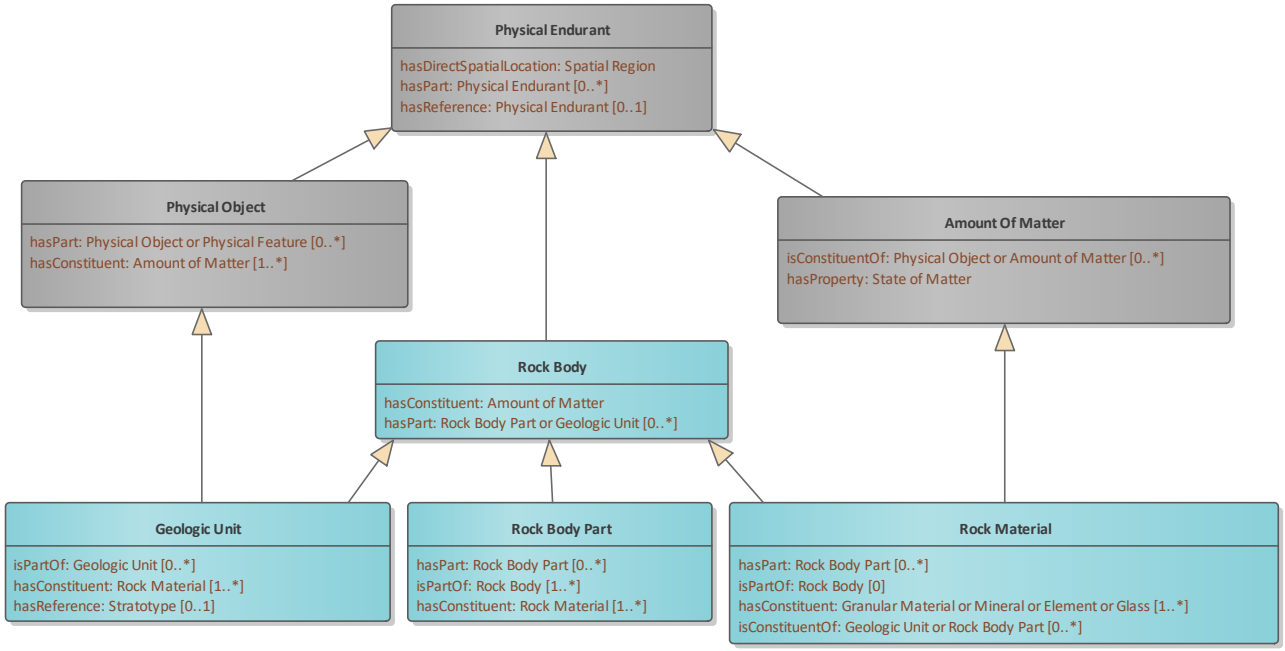

Figure 9: GSO-Rock Body

GSO-Geologic Unit diagram

Class diagram in package 'Geologic Rock Body'
A kind of geologic unit defined by particular characteristics resulting from hydrothermal interaction with a pre-existing rock body.

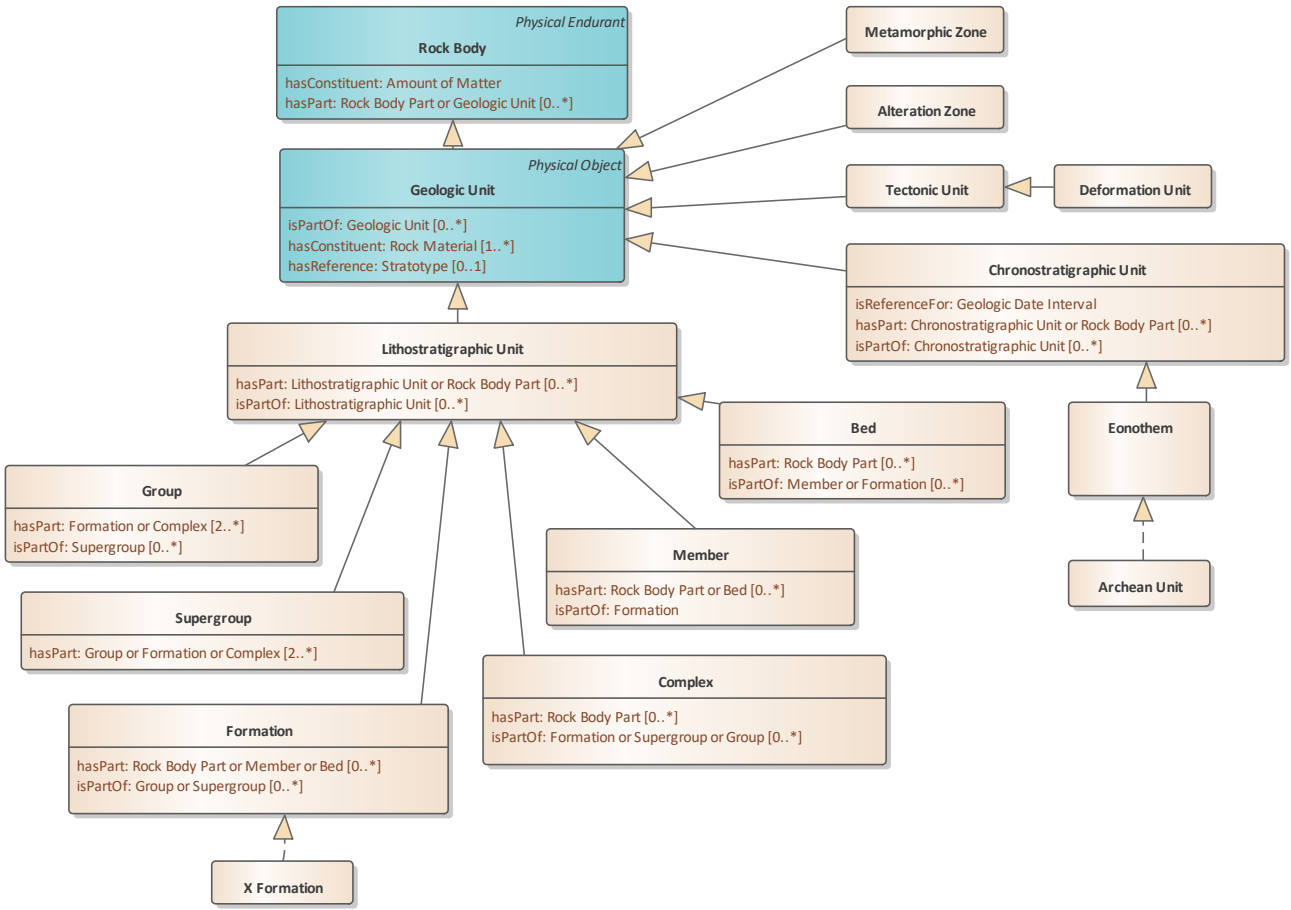

Figure 10: GSO-Geologic Unit

GSO-Rock Body Part diagram

Class diagram in package 'Geologic Rock Body'
A rock body part that is a fragment of a pre-existing rock body.

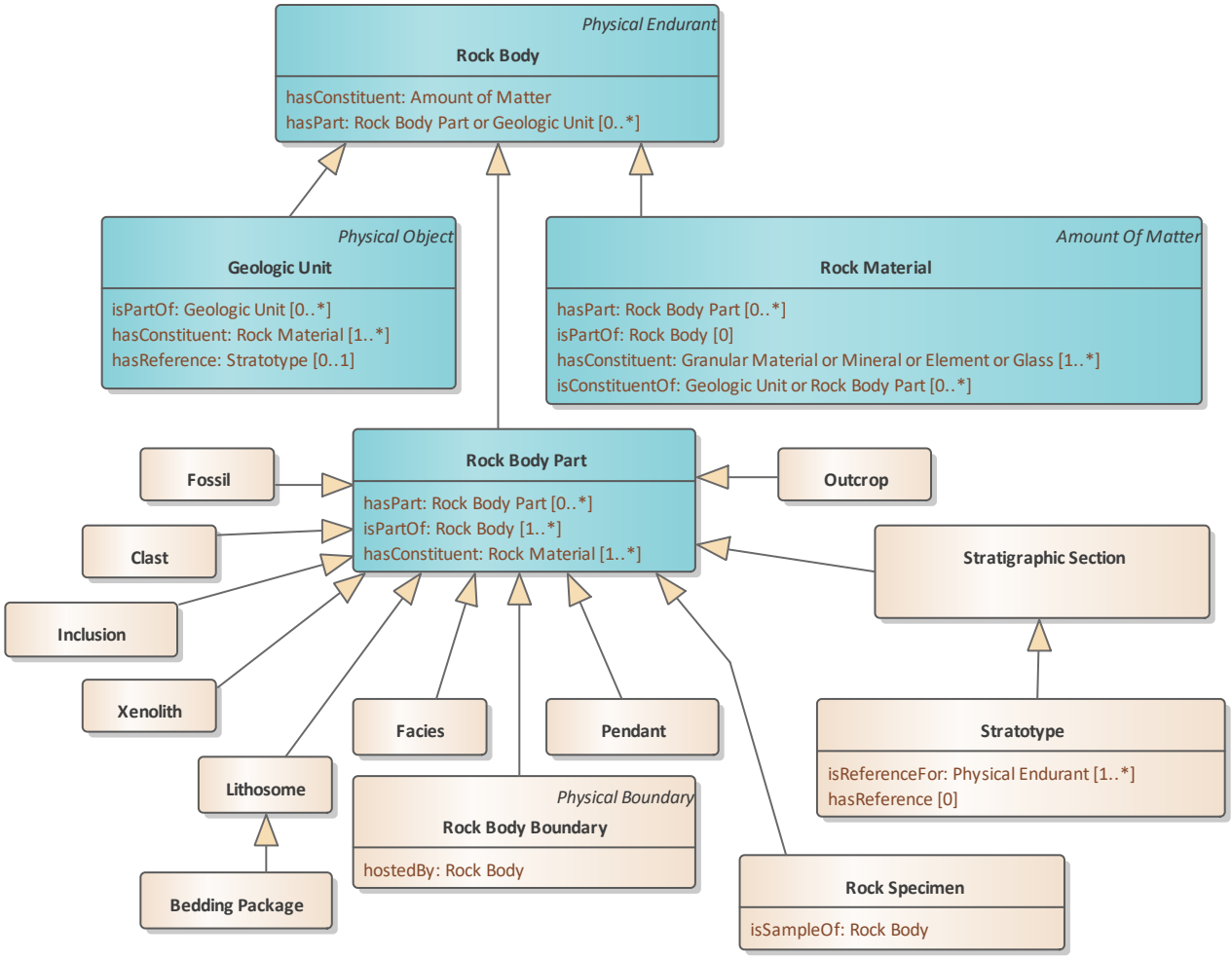

Figure 11: GSO-Rock Body Part

Geologic Setting

GSO-Geologic Setting diagram

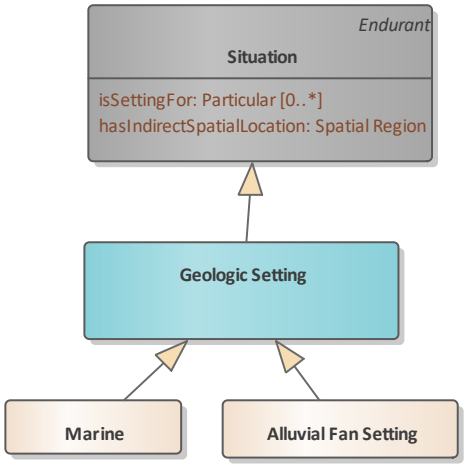

Figure 12: GSO-Geologic Setting

Geologic Structure

GSO-Structure diagram

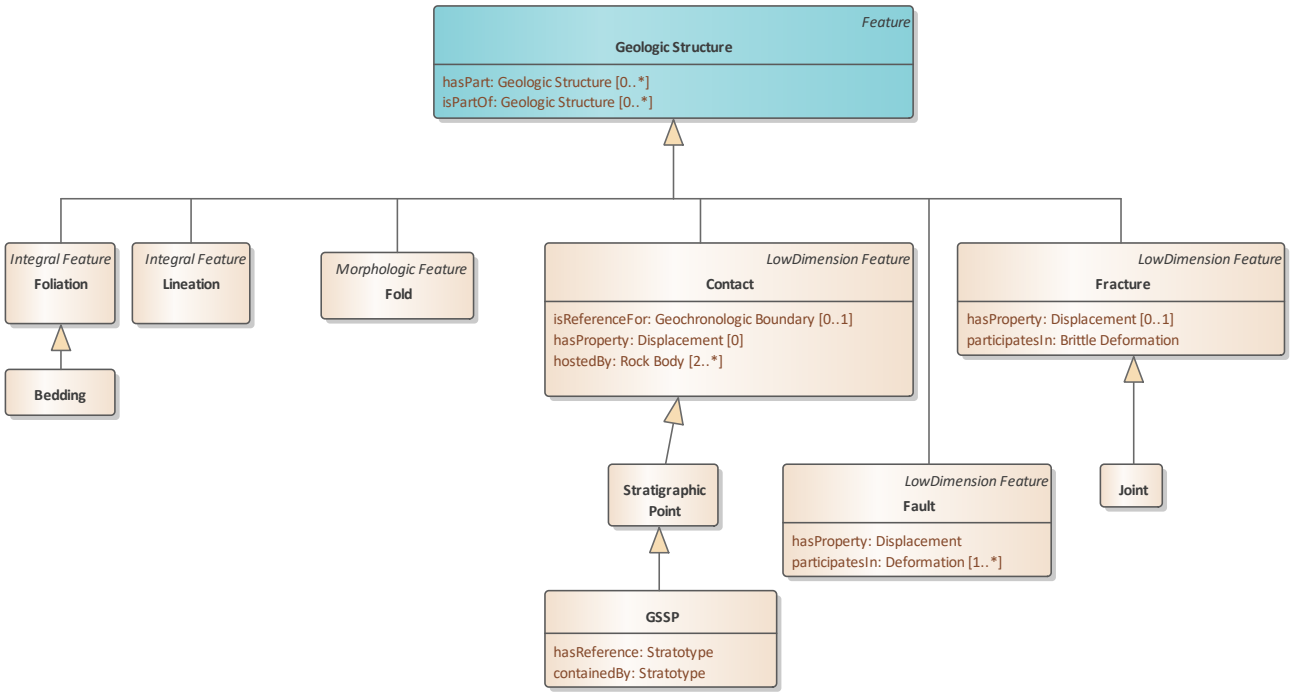

Figure 13: GSO-Structure

GSO-Fault diagram

Class diagram in package 'Geologic Structure'

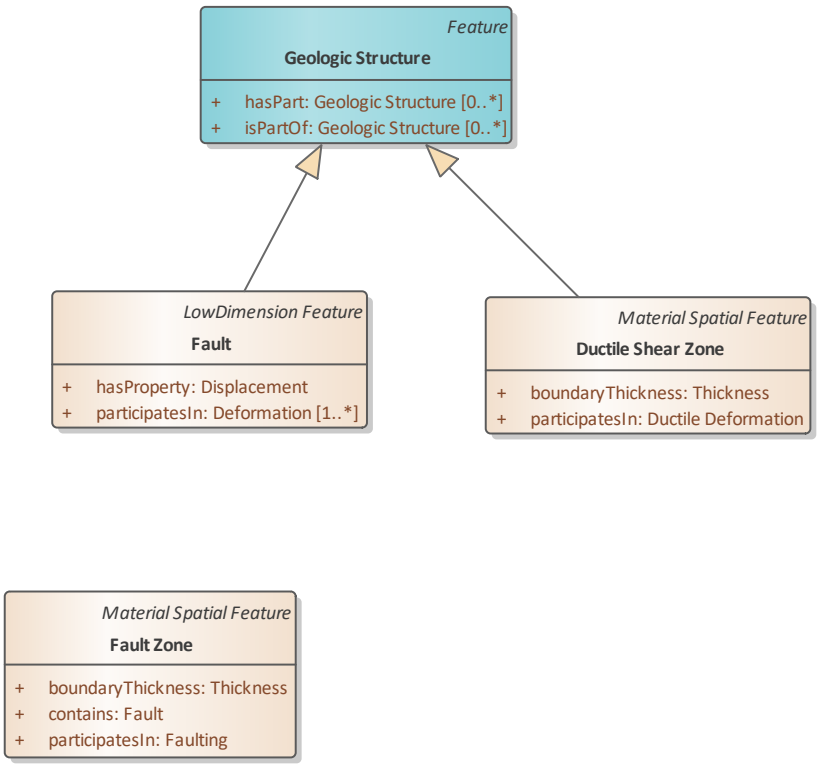

Figure 14: GSO-Fault

GSO-Fold diagram

Class diagram in package 'Geologic Structure'

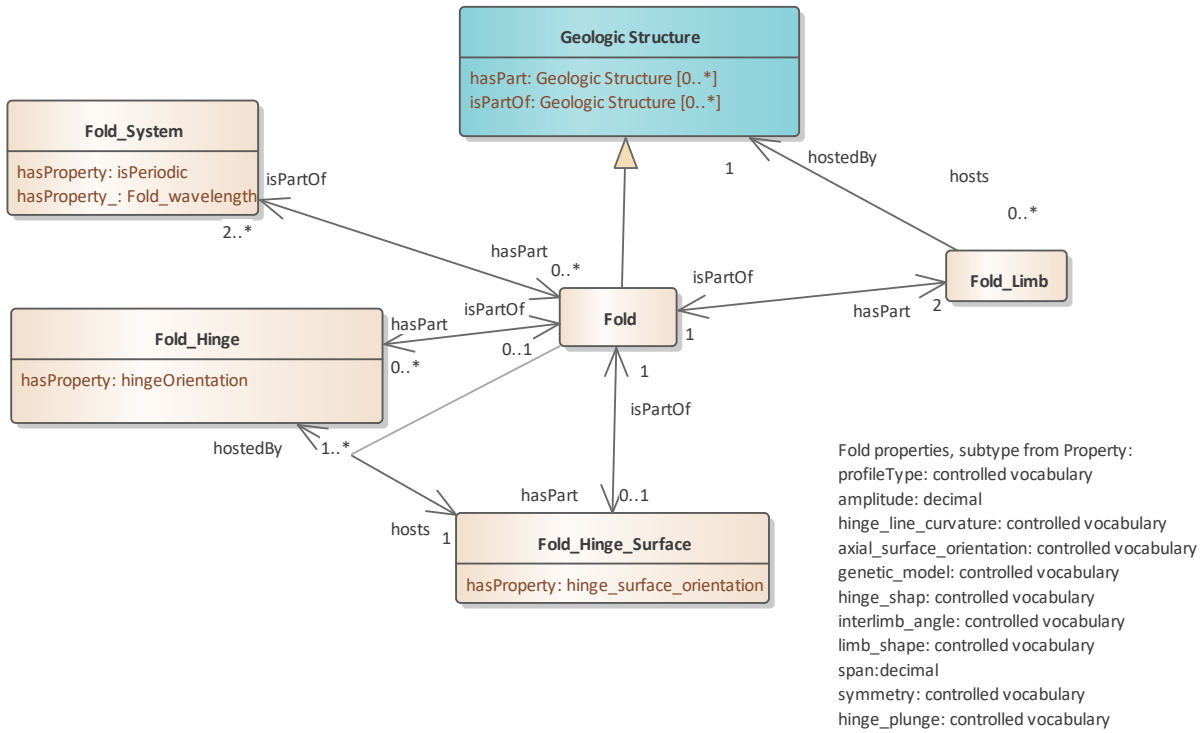

Figure 15: GSO-Fold

Classes

Alluvial Fan Setting

Class in package 'Geologic Setting'
An example of a Geologic Setting

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Alluvial Fan Setting to Geologic Setting

Alteration Zone

Class in package 'Geologic Rock Body'
A geologic unit defined by observable effects of an alteration event in a rock body. Alteration is changes in rock texture and mineralogy resulting from metasomatic processes.

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Alteration Zone to Geologic Unit

Amount Of Matter

Class in package 'Top'
The amount of matter type can be subdivided into [a volume] of (1) material (rock material), or (2) state of a material (solid, fluid), to enable designation of lumps of rock or lumps of fluid.
The common trait of amounts of matter is that they are endurants with no unity (according to Gangemi et a. 2001 none of them is an essential whole). Amounts of matter - 'stuffs' referred to by mass nouns like 'gold', 'iron', 'wood', 'sand', 'meat', etc. - are mereologically invariant, in the sense that they change their identity when they change some parts

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Amount Of Matter to Physical Endurant
Generalization from Amount Of Matter to Particular
INCOMING STRUCTURAL RELATIONSHIPS
Generalization from Granular Material to Amount Of Matter
Generalization from Element to Amount Of Matter
Generalization from Rock Material to Amount Of Matter
Generalization from Mineral to Amount Of Matter
Generalization from Glass to Amount Of Matter
ATTRIBUTES
isConstituentOf : Physical Object or Amount of Matter Multiplicity: [0..*],
hasProperty : State of Matter

Archean Unit

Class in package 'Geologic Rock Body'
An Instance of ChronostratigraphicUnit.Eonothem. Has instances that are rock body individuals that fall into the Archean age range. Thus Archean is a class, and its instances are rock body individuals.

OUTGOING STRUCTURAL RELATIONSHIPS
Realization from Archean Unit to Chronostratigraphic Unit
Realization from Archean Unit to Eonothem

B

Class in package 'Top'
Blue color band brightness value

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from B to RGB Colour Property

Bed

Class in package 'Geologic Rock Body'
A lithostratigraphic unit rank.

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Bed to Lithostratigraphic Unit

ATTRIBUTES
hasPart : Rock Body Part Multiplicity: [0..*],
isPartOf : Member or Formation Multiplicity: [0..*],

Bedding

Class in package 'Geologic Structure'

Bedding as a fabric representing the average orientation of paleodepositional surface should be encoded through the foliationType; might apply to bedding that is layering or a foliation without layering (e.g. clast alignment in amalgamated beds).

Can be dissective (penetrative) or non-dissective (non-penetrative).

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Bedding to Geologic Structure
Generalization from Bedding to Foliation

Bedding Package

Class in package 'Geologic Rock Body'

A sub-map scale sequence of strata, e.g. bouma sequence, fining-upward sequence, interbedded sandstone and mudstone...

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Bedding Package to Lithosome

Biogenic Granular Material

A granular material composed of preserved body parts, exoskeleton or shell from living organisms.

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Biogenic Granular Material to Granular Particle Material
INCOMING STRUCTURAL RELATIONSHIPS
Generalization from Crinoid Columnal to Biogenic Granular Material

Calculation

Class in package 'Geologic Process'

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Calculation to Determining Event
INCOMING STRUCTURAL RELATIONSHIPS
Generalization from Statistical Calculation to Calculation

Carbon

Example Element

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Carbon to Element

Chronostratigraphic Unit

Class in package 'Geologic Rock Body'

A geologic unit that was originated during a Geochronologic Time Interval, modeled as 'realizes' the time interval. A specific instance of Chronostratigrarphic Unit might be a reference that defines a time interval during which the unit was deposited.

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Chronostratigraphic Unit to Geologic Unit
INCOMING STRUCTURAL RELATIONSHIPS
Realization from Archean Unit to Chronostratigraphic Unit
Generalization from Eonothem to Chronostratigraphic Unit
ATTRIBUTES
isReferenceFor : Geologic Date Interval
hasPart : Chronostratigraphic Unit or Rock Body Part Multiplicity: [0..*],

OUTGOING STRUCTURAL RELATIONSHIPS
isPartOf : Chronostratigraphic Unit Multiplicity: [0..*],

Clast

Class in package 'Geologic Rock Body'

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Clast to Rock Body Part

Clastic Granular Material

Use for clastic sedimentary components --conglomerate clast types, sand components, clay matrix. Also for deformation-producted clasts in tectonic breccia.

Clastic Granular Material

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Clastic Granular Material to Granular Particle Material
INCOMING STRUCTURAL RELATIONSHIPS
Generalization from Pyroclastic Granular Material to Clastic Granular Material

Colour

Class in package 'Top'

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Colour to Property
INCOMING STRUCTURAL RELATIONSHIPS
Generalization from RGB Colour to Colour

Complex

Class in package 'Geologic Rock Body'

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Complex to Lithostratigraphic Unit
ATTRIBUTES
hasPart : Rock Body Part Multiplicity: [0..*],
isPartOf : Formation or Supergroup or Group Multiplicity: [0..*],

Complex Feature

Class in package 'Geologic Structure'

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Complex Feature to Part Feature

Contact

Class in package 'Geologic Structure'

Contact (CT): Feature hosted by 2 or more rock bodies that touch; not a part of any of the touching rock bodies.
A contact is realizedBy 2 Rock Body Surfaces; each is a part of a different Rock Body host that is in contact.
Contact(x) <--> exists y,z [host(y,x) ^ host(z,x) ^ touches (y,z) ^ RBS (y) ^ RBS (z)]

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Contact to LowDimension Feature
Generalization from Contact to Geologic Structure
Generalization from Contact to Geologic Structure
INCOMING STRUCTURAL RELATIONSHIPS
Generalization from Stratigraphic Point to Contact
ATTRIBUTES
isReferenceFor : Geochronologic Boundary Multiplicity: [0..1],
hasProperty : Displacement

OUTGOING STRUCTURAL RELATIONSHIPS
Multiplicity: [0],
hostedBy : Rock Body Multiplicity: [2..*],

Contact Metamorphism

Class in package 'Geologic Process'

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Contact Metamorphism to Metamorphism

Crinoid Columnal

Class in package 'Geologic Rock Body'

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Crinoid Columnal to Biogenic Granular Material

Crystallized Granular Material

Constituent particles/grains that are the product of crystallization during formation of a rock material (see NADMC1 2004). Serves to distinguish crystalline from granular rocks (Struik, 2002). Includes constituents crystallized in evaporite environments, during diagenesis or hydrothermal alteration, or in other low-temperature environments
use to describe crystalline grain types in igneous, metamorphic and metasomatic rocks, e.g. the plagioclase phenocrysts, groundmass quartz, biotite phenocrysts, Andalusite porphyroblasts.

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Crystallized Granular Material to Granular Material

Deformation

Class in package 'Geologic Process'

Parent class for processes that change the shape or location of geologic entities. Includes strain and translation.

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Deformation to Geologic Process
INCOMING STRUCTURAL RELATIONSHIPS
Generalization from Ductile Deformation to Deformation
Generalization from Brittle Deformation to Deformation
Generalization from Faulting to Deformation

Deformation Unit

Class in package 'Geologic Rock Body'

A geologic unit defined by observable effects of a deformation event in a rock body.

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Deformation Unit to Tectonic Unit

Deposition

Class in package 'Geologic Process'

An example of a Geologic Process

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Deposition to AdditiveProcess

Determining Event

Class in package 'Geologic Process'

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Determining Event to Event
INCOMING STRUCTURAL RELATIONSHIPS
Generalization from Calculation to Determining Event
Generalization from Observation to Determining Event
Generalization from Inference to Determining Event

Dip

Class in package 'Top'

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Dip to Orientation
ATTRIBUTES
hasDataValue : Number
hasUOM : Unit of Measure

Ductile Deformation

Class in package 'Geologic Process'

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Ductile Deformation to Deformation

Ductile Shear Zone

Class in package 'Geologic Structure'

Ductile Shear Zone (DSZ): a generally surface-like zone across which rock bodies have been displaces. Distinguished from fault by the absence of through-going fractures (material discontinuities) separating adjacent rock bodies. Narrower than gsml:shearDisplacementStructure, which is broader because it includes faults.

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Ductile Shear Zone to Material Spatial Feature
Generalization from Ductile Shear Zone to Geologic Structure
ATTRIBUTES
boundaryThickness : Thickness
participatesIn : Ductile Deformation

Dynamic Feature

Class in package 'Geologic Structure'

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Dynamic Feature to Feature

Element

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Element to Amount Of Matter
INCOMING STRUCTURAL RELATIONSHIPS
Generalization from Carbon to Element
ATTRIBUTES
isConstituentOf : Rock Material or Granular Material or Mineral Multiplicity: [0..*],

Endurant

Class in package 'Top'

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Endurant to Particular
INCOMING STRUCTURAL RELATIONSHIPS
Generalization from Physical Endurant to Endurant
Generalization from Feature to Endurant
Generalization from Spatial Region to Endurant
Generalization from Property to Endurant
Generalization from Situation to Endurant
ATTRIBUTES
hasIndirectTemporalLocation : Time Region
hasPart : Endurant Multiplicity: [0..*], Allow duplicates: 0, Is ordered: False)
isParticipantIn : Process or Event

OUTGOING STRUCTURAL RELATIONSHIPS
Multiplicity: [1..*], Allow duplicates: 0, Is ordered: False)
hasReference : Endurant Multiplicity: [0..1], Allow duplicates: 0, Is ordered: False)

Eon

Class in package 'Geologic Time'

The Chronostratigraphic equivalent is an eonothem. 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.

[SMR note: Implication is that Precambrian Eon is subdivided into the Archean and Proterozoic (an apparently the Hadean) Eons.]

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Eon to Geologic Date Interval
INCOMING STRUCTURAL RELATIONSHIPS
Realization from Archean to Eon
ATTRIBUTES
hasPart : Era or Eon Multiplicity: [2..*],
isPartOf : Eon

Eonothem

Class in package 'Geologic Time'

Kind of Chronostratigraphic Unit

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Eonothem to Chronostratigraphic Unit

INCOMING STRUCTURAL RELATIONSHIPS
Realization from Archean Unit to Eonothem

Epoch

Class in package 'Geologic Time'

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Epoch to Geologic Date Interval

ATTRIBUTES
hasPart : Age Multiplicity: [0..*],
isPartOf : Period Private

Era

Class in package 'Geologic Time'

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Era to Geologic Date Interval

ATTRIBUTES
hasPart : Period Multiplicity: [2..*],
isPartOf : Eon

Erosion

Class in package 'Geologic Process'

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Faulting to Deformation

Esker

Class in package 'Geologic Structure'
An example of an Indissective Morphological Feature.

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Esker to Morphologic Feature

Event

Class in package 'Top'
A event is an occurence that involves a change in state of some system. "Something that occurs in a certain place during a particular interval of time" (https://www.dictionary.com/browse/event); "an occurrence; something that happens" (https://wikidiff.com/event/process). Event is dependent on at least one process

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Event to Perdurant

INCOMING STRUCTURAL RELATIONSHIPS
Generalization from Determining Event to Event
Generalization from Geologic Event to Event

ATTRIBUTES
hasDirectTemporalLocation : Time Region
hasIndirectSpatialLocation : Spatial Region
hasPart : Event Multiplicity: [0..*], Allow duplicates: 0, Is ordered: False)
hasParticipant : Endurant Multiplicity: [1..*], Allow duplicates: 0, Is ordered: False)
hasConstituent : Process
hasReference : Event

Facies

Class in package 'Geologic Rock Body'
A part of a rock body that is differentiated based on observable characteristics, but is interpreted to be broadly coeval with other parts of the unit. Facies can be defined based on interpretations of depositional environment, metamorphic or alteration conditions, or variations in mineralogy in igneous rock.
Represents a particular body of rock that is a lateral variant of a lithostratigraphic unit, or a variant of a lithodemic unit.
http://inspire.ec.europa.eu/codelist/CompositionPartRoleValue/facies

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Facies to Rock Body Part

Fault

Class in package 'Geologic Structure'
Fault (FLT)
A surface across which there has been large displacement of rock bodies, characterized by brittle deformation. This structure may have some mappable thickness (a deformation zone) and have an associated body of deformed rock. Narrower than gsml:shearDisplacementStructure, which is broader, because it includes ductile shear zones.

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Fault to LowDimension Feature
Generalization from Fault to Geologic Structure

ATTRIBUTES
hasProperty : Displacement
participatesIn : Deformation Multiplicity: [1..*],

Fault Zone

Class in package 'Geologic Structure'

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Fault Zone to Material Spatial Feature

ATTRIBUTES
boundaryThickness : Thickness
contains : Fault
participatesIn : Faulting

Feature

Class in package 'Top'
Feature (F):
All features are specifically dependent on their hosts - that is, the hosts relation is a subrelation of specific dependence.
F(x) <--> exists y [hosts(y,x)]
Feature

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Feature to Endurant
INCOMING STRUCTURAL RELATIONSHIPS
Generalization from Part Feature to Feature
Generalization from Inherent Feature to Feature
Generalization from Geologic Structure to Feature
Generalization from Integral Feature to Feature
Generalization from Spatial Feature to Feature
Generalization from Dynamic Feature to Feature
ATTRIBUTES
isColocatedWith : Particular Multiplicity: [1..*],
hostedBy : Endurant Multiplicity: [1..*],

First Standard Deviation Calculation

Class in package 'Geologic Process'
An interval around a measurement result value that is asserted to include 68% of repeat measurement results for the same value.

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from First Standard Deviation Calculation to Statistical Calculation

Fluid

Class in package 'Top'

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Fluid to State of Matter
INCOMING STRUCTURAL RELATIONSHIPS
Generalization from Gas to Fluid
Generalization from Plasma to Fluid
Generalization from Liquid to Fluid

Fold

Class in package 'Geologic Structure'
Fold (FLD):
Folds are a pattern in the shape of the rock body.
GeoSciML v3.2: One or more systematically curved layers, surfaces, or lines in a rock body. Fold denotes a structure formed by the deformation of a GeologicStructure to form a structure that may be described by the translation of an abstract line (the fold axis) parallel to itself along some curvilinear path (the fold profile). Folds have a hinge zone (zone of maximum curvature along the surface) and limbs (parts of the deformed surface not in the hinge zone). Folds are described by an axial surface, hinge line , profile geometry, the solid angle between the limbs, and the relationships between adjacent folded surfaces if the folded structure is a Layering fabric (similar, parallel).
FLD(x) <--> exists z, y [hosts(z,x) ^ partOf(y,z) ^ RB(y) ^ RB(z) --> not exists x1 [hosts(y,x1) ^ FLD(x1)]]
Fold hasProperty:
profileType: controlled vocabulary
amplitude: decimal
hinge_line_curvature: controlled vocabulary

axial_surface_orientation: controlled vocabulary
genetic_model: controlled vocabulary
hinge_shap: controlled vocabulary
interlimb_angle: controlled vocabulary
limb_shape: controlled vocabulary
span:decimal
symmetry: controlled vocabulary
hinge_plunge: controlled vocabulary

OUTGOING STRUCTURAL RELATIONSHIPS

- Generalization from Fold to Morphologic Feature
- Generalization from Fold to Geologic Structure

ASSOCIATIONS

- Association (direction: Unspecified)
  Source: Public (ProxyConnector) ProxyConnector — Target: Public (Class) Fold
- Association (direction: Bi-Directional)
  Source: Public hasPart (Class) Fold_Hinge_Surface — Cardinality: [0..1]
  Target: Public isPartOf (Class) Fold — Cardinality: [1]
- Association (direction: Bi-Directional)
  Source: Public hasPart (Class) Fold_Limb — Cardinality: [2]
  Target: Public isPartOf (Class) Fold — Cardinality: [1]
- Association (direction: Bi-Directional)
  Source: Public hasPart (Class) Fold_Hinge — Cardinality: [0..*]
  Target: Public isPartOf (Class) Fold — Cardinality: [0..1]
- Association (direction: Bi-Directional)
  Source: Public isPartOf (Class) Fold_System — Cardinality: [2..*]
  Target: Public hasPart (Class) Fold — Cardinality: [0..*]

Fold_Hinge

Class in package 'Geologic Structure'

OUTGOING STRUCTURAL RELATIONSHIPS

- Generalization from Foliation to Geologic Structure
- Generalization from Foliation to Integral Feature
- Generalization from Foliation to Geologic Structure

INCOMING STRUCTURAL RELATIONSHIPS

- Generalization from Bedding to Foliation

Formation

Class in package 'Geologic Rock Body'
A lithostratigraphic unit rank.

OUTGOING STRUCTURAL RELATIONSHIPS

- Generalization from Formation to Lithostratigraphic Unit

INCOMING STRUCTURAL RELATIONSHIPS

- Realization from X Formation to Formation

ATTRIBUTES

- hasPart : Rock Body Part or Member or Bed
  Multiplicity: [0..*],
- isPartOf : Group or Supergroup
  Multiplicity: [0..*],

Fossil

Class in package 'Geologic Rock Body'
A constituent part of a rock body that is a preserved part of a living organism, its exoskeleton, or a shell.
Note this concept does not include Fossil Molds and Trace Fossils, which are considered types of non-directional Geologic Structures.

OUTGOING STRUCTURAL RELATIONSHIPS

- Generalization from Fossil to Rock Body Part

Fracture

Class in package 'Geologic Structure'
Fracture (FR):
FR is a Geologic Structure:
- hosted by two or more rock bodies
- hosting a gap created by breaking rock
- not a part of any of the hosting rock bodies
Fractures are cracks in the Earth. If there is no displacement it is a joint. Fractures are not contacts because the rock bodies that host a fracture do not touch; either some open space, vein-filling, or fault rock separates the two rock bodies, but the width of the fracture void or filling can be very small. Some fault zone separates the rock bodies.

OUTGOING STRUCTURAL RELATIONSHIPS

- Generalization from Fracture to Geologic Structure
- Generalization from Fracture to LowDimension Feature
- Generalization from Fracture to Geologic Structure

INCOMING STRUCTURAL RELATIONSHIPS

- Generalization from Joint to Fracture

ATTRIBUTES

- hasProperty : Displacement
  Multiplicity: [0..1],
- participatesIn : Brittle Deformation

G

Class in package 'Top'
Green color band brightness value

OUTGOING STRUCTURAL RELATIONSHIPS

- Generalization from G to RGB Colour Property

Gap

Class in package 'Geologic Structure'
Gap (G):
A physical void with a scattered (disconnected) host, consisting of the spaces between the scattered parts of the host.
G(x) <--> exists y [hosts-v(y,x) ^ not ICon (y)]
ICon (x): x is interior connected (continuous, not scattered)

OUTGOING STRUCTURAL RELATIONSHIPS

- Generalization from Gap to Physical Void

Gas

Class in package 'Top'
a state of matter that has no fixed shape and no fixed volume. Gases have lower density than other states of matter, such as solids and liquids. https://www.livescience.com/53304-gases.html

OUTGOING STRUCTURAL RELATIONSHIPS

- Generalization from Gas to Fluid

Geochronologic Boundary

Class in package 'Geologic Time'
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
  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)

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

Geologic Age

Class in package 'Geologic Time'
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 Date Interval

Class in package 'Geologic Time'
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.

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Geologic Date Interval to Time Interval
INCOMING STRUCTURAL RELATIONSHIPS
Generalization from Eon to Geologic Date Interval
Generalization from Period to Geologic Date Interval
Generalization from Epoch to Geologic Date Interval
Generalization from Age to Geologic Date Interval
Generalization from Era to Geologic Date Interval
ATTRIBUTES
hasYoungerDate : Time Instant Multiplicity: [0..1], sameAs gts:end
hasOlderDate : Time Instant Multiplicity: [0..1], sameAs gts:start
hasPart : Geologic Date Interval Multiplicity: [0..*],
isPartOf : Time Interval Multiplicity: [0..1],
hasReference : Chronostratigraphic Unit Multiplicity: [0..1],
previousTimeInterval : Geologic Date Interval Multiplicity: [0..*],
nextTimeInterval : Geologic Date Interval Multiplicity: [0..*],
ASSOCIATIONS
Association (direction: Unspecified) Source: Public hasYoungerBound (Class) Geochronologic Boundary — Target: Public previousTimeInterval (Class) Geologic Date Interval Cardinality: [0..*]
Association (direction: Unspecified) Source: Public hasOlderBound (Class) Geochronologic Boundary — Target: Public nextTimeInterval (Class) Geologic Date Interval Cardinality: [0..*]

Geologic Event

Class in package 'Geologic Process'
A Geologic Perdurant that is the manifestation of one or more Geologic Processes. Any restrictions on participants of the

manifested process also apply to participants of the event.
GeoSciML 3.2: An identifiable event during which one or more geological processes act to modify geological entities. A Geologic Event must have a specified Geologic Age and may have specified setting and process(es). An example might be a cratonic uplift event during which erosion, sedimentation, and volcanism all take place.
causedBy (x,y) ^ GeologicEvent (x) ^ GeologicProcess (y) --> forall z [participates(z,x) --> participates (z,y)]

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Geologic Event to Event
INCOMING STRUCTURAL RELATIONSHIPS
Generalization from magnetic_field_reversal to Geologic Event
Generalization from bolide_impact to Geologic Event
ATTRIBUTES
hasConstituent : Geologic Process Multiplicity: [1..*],

Geologic Process

Class in package 'Geologic Process'

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Geologic Process to Process
INCOMING STRUCTURAL RELATIONSHIPS
Generalization from Deformation to Geologic Process
Generalization from AdditiveProcess to Geologic Process
Generalization from Transformation to Geologic Process
Generalization from SubtractiveProcess to Geologic Process
ATTRIBUTES
isConstituentOf : Geologic Event Multiplicity: [1..*],

Geologic Setting

Class in package 'Top'
A physical setting might be defined by parts that are endurants or perdurants, and also by particular qualities/properties. Thus it is a direct subtype of Particular.

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Geologic Setting to Situation
INCOMING STRUCTURAL RELATIONSHIPS
Generalization from Marine to Geologic Setting
Generalization from Alluvial Fan Setting to Geologic Setting

Geologic Structure

Class in package 'Geologic Structure'
Geologic Structure (GS):
A pattern in a rock body (foliation, fold), or a feature occurring between rock bodies (contact, fracture).
GeoSciML 3.2: A configuration of matter in the Earth based on describable inhomogeneity, pattern, or fracture in a Rock Body.
The identity of a GeologicStructure is independent of the material that is the substrate for the structure.
Properties like "clast-supported", "matrix-supported", and "graded bed" that do not involve orientation are considered kinds of GeologicStructure because they depend on the configuration of parts of a rock body. Includes sedimentary structures.

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Geologic Structure to Feature
INCOMING STRUCTURAL RELATIONSHIPS
Generalization from Foliation to Geologic Structure
Generalization from Ductile Shear Zone to Geologic Structure
Generalization from Fold_Hinge_Surface to Geologic Structure
Generalization from Lineation to Geologic Structure
Generalization from Foliation to Geologic Structure
Generalization from Fold_Hinge to Geologic Structure

OUTGOING STRUCTURAL RELATIONSHIPS

- Generalization from Contact to Geologic Structure
- Generalization from Contact to Geologic Structure
- Generalization from Bedding to Geologic Structure
- Generalization from Fold_System to Geologic Structure
- Generalization from Fracture to Geologic Structure
- Generalization from Fault to Geologic Structure
- Generalization from Lineation to Geologic Structure
- Generalization from Fracture to Geologic Structure
- Generalization from Fold to Geologic Structure

ATTRIBUTES

hasPart : Geologic Structure
Multiplicity: [0..*],

isPartOf : Geologic Structure
Multiplicity: [0..*],

ASSOCIATIONS

Association (direction: Source -> Destination)
Source: Public hosts (Class) Fold_Limb
Cardinality: [0..*]
Target: Public hostedBy (Class) Geologic Structure
Cardinality: [1]

Geologic Time Date

Class in package 'Geologic Time'

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 GSSA to Geologic Time Date
- Generalization from Geochronologic Boundary to Geologic Time Date

ATTRIBUTES

hasDate : double

hasUOM : UOM

hasProperty_ : Simple Uncertainty
Multiplicity: [0..1],

hasProperty : Statistical Calculation
Multiplicity: [0..*],
for expressing statistics on quality, uncertainty.

Geologic TIme Interval

Class in package 'Geologic Time'

OUTGOING STRUCTURAL RELATIONSHIPS

- Generalization from Geologic Time Scale to Time Interval

INCOMING STRUCTURAL RELATIONSHIPS

- Realization from IUGS 2014 Time Scale to Geologic Time Scale

ATTRIBUTES

hasPart : Geologic Date Interval
Multiplicity: [1..*],

Geologic Time Scale

Class in package 'Geologic Time'

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).

OUTGOING STRUCTURAL RELATIONSHIPS

- Generalization from Geologic Time Scale to Time Interval

INCOMING STRUCTURAL RELATIONSHIPS
Realization from IUGS 2014 Time Scale to Geologic Time Scale
ATTRIBUTES
hasPart : Geologic Date Interval Multiplicity: [1..*],

Geologic Unit

Class in package 'Geologic Rock Body'

This is the root concept for the geologic unit type hierarchy.. A body of material in the Earth whose complete and precise extent is inferred to exist (NADM GeologicUnit, Stratigraphic unit in sense of NACSN or International Stratigraphic Code), or a classifier used to characterize parts of the Earth (e.g. lithologic map unit like 'granitic rock' or 'alluvial deposit', surficial units like 'till' or 'old alluvium'). (GeoSciML v3.2)

A geologic unit and (the amount of) its rock material are co-located, but different entities. They can share properties, e.g. porosity, thickness, density, but also have differences:

- different persistence conditions: the material can exist without the unit; e.g. a unit can be cease to exist due to natural (seismic) or artificial (explosion) means, but the material can persist
- different parthood conditions:
-- a unit can be part of a stratigraphic lexicon, but its material cannot be part of the lexicon.
-- parts of the unit are not parts of the material, e.g. the western arm of formation X is not a part of its sandstone - the sandstone making up the western part of X is a part of the sandstone
-- different identity conditions: a unit can have some material added or removed and retain identity, but the material changes identity with the addition or removal of some material

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Geologic Unit to Rock Body
Generalization from Geologic Unit to Physical Object
INCOMING STRUCTURAL RELATIONSHIPS
Generalization from Chronostratigraphic Unit to Geologic Unit
Generalization from Tectonic Unit to Geologic Unit
Generalization from Metamorphic Zone to Geologic Unit
Generalization from Alteration Zone to Geologic Unit
Generalization from Lithostratigraphic Unit to Geologic Unit
ATTRIBUTES
isPartOf : Geologic Unit Multiplicity: [0..*],
hasConstituent : Rock Material Multiplicity: [1..*],
hasReference : Stratotype Multiplicity: [0..1],

Glass

Amorphous product of rapid cooling of melted earth material. Formed by volcanic processes, bolide impact, or frictional melting.

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Glass to Amount Of Matter
INCOMING STRUCTURAL RELATIONSHIPS
Generalization from Volcanic Glass to Glass
ATTRIBUTES
hasConstituent : Element Multiplicity: [1..*],
isConstituentOf : Rock Material or Granular Material Multiplicity: [0..*],

Gradational Contact Zone

Class in package 'Geologic Structure'

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Gradational Contact Zone to Material Spatial Feature
ATTRIBUTES
boundaryThickness : Thickness

OUTGOING STRUCTURAL RELATIONSHIPS
contains : Contact

Grain Shape

Class in package 'Top'
Example categorical physical geologic property.

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Grain Shape to Property
INCOMING STRUCTURAL RELATIONSHIPS
Generalization from Subangular to Grain Shape

Grain Type

Class in package 'Geologic Rock Body'

Granular Material

Represents a rock body constituent composed of particles that share a set of characteristics, e.g. particle size (distribution), mineralogy, shape. E.g. the sand that is a constituent in a sandstone, or the feldspar phenocrysts that are a constituent in a granite.

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Granular Material to Amount Of Matter
INCOMING STRUCTURAL RELATIONSHIPS
Generalization from Crystallized Granular Material to Granular Material
Generalization from Granular Particle Material to Granular Material
ATTRIBUTES
hasConstituent : Mineral or Element or Glass Multiplicity: [1..*],
isConstituentOf : Rock Material Multiplicity: [0..1],

Granular Particle Material

Material consisting of a collection of pre-existing objects (particles, grains) before incorporation into a particulate aggregate. \...a component of solid material that has the form of grains, clasts, fragments, or whole objects of any size, shape, composition, texture, and structure.\ (NADMSC SLTTs, 2004)

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Mineral to Amount Of Matter
INCOMING STRUCTURAL RELATIONSHIPS
Generalization from Quartz to Mineral
ATTRIBUTES
hasConstituent : Element Multiplicity: [1..*],
isConstituentOf : Rock Material or Granular Material Multiplicity: [0..*],

Group

Class in package 'Geologic Rock Body'
A lithostratigraphic unit rank, includes 2 or more formations (http://www.stratigraphy.org/upload/bak/litho.htm). A succession of two or more contiguous or associated formations with significant and diagnostic lithologic properties in common. Formations need not be aggregated into groups unless doing so provides a useful means of simplifying stratigraphic classification in certain regions or certain intervals. Thickness of a stratigraphic succession is not a valid reason for defining a unit as a group rather than a formation. The component formations of a group need not be everywhere the same.

ATTRIBUTES
hasPart : Formation or Complex Multiplicity: [2..*],
isPartOf : Supergroup Multiplicity: [0..*],

GSSA

Class in package 'Geologic Time'
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.

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from GSSA to Geologic Time Date
ATTRIBUTES
hasProperty : Simple Uncertainty Multiplicity: [0],

GSSP

Class in package 'Geologic Structure'
A stratigraphic point that is hosted by a top and bottom segment of adjacent chronostratigraphic units. The top and bottom are part of an outcrop and part of a stratotype (type section) for the unit.

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from GSSP to Stratigraphic Point
ATTRIBUTES
hasReference : Stratotype
containedBy : Stratotype

Hole

Class in package 'Geologic Structure'
Hole (H):
A physical void with a self-connected (non-scattered) host, consisting of some depression or cavity within the host.
H(x) <--> exists y [hosts-v(y,x) ^ ICon (y)]
ICon (x): x is interior connected (continuous, not scattered)

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Hole to Physical Void

Immaterial Feature

Class in package 'Geologic Structure'
Material Place Feature (IPF):
A dependent place feature that is immaterial.
E.g. voids, shadows and relational features such as traffic intersections (meeting of roads).
MPF(x) <--> DPF(x) ^ not mat(x)

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Immaterial Feature to Spatial Feature
INCOMING STRUCTURAL RELATIONSHIPS
Generalization from LowDimension Feature to Immaterial Feature
Generalization from Place Feature to Immaterial Feature

Inclusion

Class in package 'Geologic Rock Body'
A rock body part that is an incidental occurrence of

Inference

Class in package 'Geologic Process'

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Inference to Determining Event

Inherent Feature

Class in package 'Geologic Structure'

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Inherent Feature to Feature
INCOMING STRUCTURAL RELATIONSHIPS
Generalization from Morphologic Feature to Inherent Feature
ATTRIBUTES
colocatedWith : Physical Property

Integral Feature

Class in package 'Geologic Structure'

Integral features are dissective - every part of a foliation is also a foliation (at a scale of observation).
Integral features are integral wholes with unified parts.
e.g. A Lineation (L1) is a collection of individual features (linear alignment of entities) unified by a specific causal perdurant. Same for foliations, except as planar surfaces.

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Integral Feature to Feature
INCOMING STRUCTURAL RELATIONSHIPS
Generalization from Foliation to Integral Feature
Generalization from Lineation to Integral Feature

Intrusion

Class in package 'Geologic Process'

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Intrusion to AdditiveProcess

IUGS 2014 Time Scale

Class in package 'Geologic Time'

OUTGOING STRUCTURAL RELATIONSHIPS
Realization from IUGS 2014 Time Scale to Geologic Time Scale
CONNECTORS
Dependency Source -> Destination From: Archean : Class, Public hasPart To: IUGS 2014 Time Scale : Class, Public isPartOf

Joint

Class in package 'Geologic Structure'

Joint (J): Fracture across which there is small displacement at the scale of interest.

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Joint to Fracture

Le Maitre Rock Material Classification

Class in package 'Geologic Rock Body'

Igneous Rock material classification based on Quartz-feldspar and mafic mineral modal composition, LeMaitre et al, IUGS

Lineation

Class in package 'Geologic Structure'

Geologic Structure defined by aligned elongate elements. Lineation connotes a pervasive (dissective) linear structure. Includes: flow lines, linear arrangements of elongate components in sediments, fold hinges (when abundant and closely spaced), elongate minerals, crinkles, and lines of intersection between penetrative planar structures. In a Geologic Surface: scratches, striae, slickenlines,
Class also includes discrete linear structures like boudin, channel axis, tool marks.

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Lineation to Geologic Structure
Generalization from Lineation to Geologic Structure

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Lineation to Integral Feature

Liquid

Class in package 'Top'

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Liquid to Fluid

Lithosome

Class in package 'Geologic Rock Body'

A kind of rock body that has multiple occurrences in a single geologic unit. A mass of rock of uniform character, characterized by geometry, composition, and internal structure.
(http://inspire.ec.europa.eu/codelist/CompositionPartRoleValue/lithosome)

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Lithosome to Rock Body Part
INCOMING STRUCTURAL RELATIONSHIPS
Generalization from Bedding Package to Lithosome

Lithostratigraphic Unit

Class in package 'Geologic Rock Body'

A body of rocks that is defined and recognized on the basis of its lithologic properties or combination of lithologic properties and stratigraphic relations.
A lithostratigraphic unit may consist of sedimentary, or igneous, or metamorphic rocks. Lithostratigraphic units are defined and recognized by observable physical features and not by their inferred age, the time span they represent, inferred geologic history, or manner of formation.
The geographic extent of a lithostratigraphic unit is controlled entirely by the continuity and extent of its diagnostic lithologic features.
see http://www.stratigraphy.org/upload/bak/litho.htm
Use to represent A geologic unit part that occupies a particular stratigraphic position within a geologic unit.
http://inspire.ec.europa.eu/codelist/CompositionPartRoleValue/stratigraphicPart

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Lithostratigraphic Unit to Geologic Unit
INCOMING STRUCTURAL RELATIONSHIPS
Generalization from Formation to Lithostratigraphic Unit
Generalization from Group to Lithostratigraphic Unit
Generalization from Member to Lithostratigraphic Unit
Generalization from Bed to Lithostratigraphic Unit
Generalization from Supergroup to Lithostratigraphic Unit
Generalization from Complex to Lithostratigraphic Unit
ATTRIBUTES
hasPart : Lithostratigraphic Unit or Rock Body Part Multiplicity: [0..*],
isPartOf : Lithostratigraphic Unit Multiplicity: [0..*],

LowDimension Feature

Class in package 'Geologic Structure'

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from LowDimension Feature to Immaterial Feature
INCOMING STRUCTURAL RELATIONSHIPS
Generalization from Contact to LowDimension Feature
Generalization from Fault to LowDimension Feature
Generalization from Fracture to LowDimension Feature

Ma

Class in package 'Top'

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Ma to Unit of Measure

Magnetic Field Reversal

Class in package 'Geologic Process'

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Maximum Calculation to Statistical Calculation

Marine

Class in package 'Geologic Setting'

An example Geologic Setting

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Marine to Geologic Setting

Material Spatial Feature

Class in package 'Geologic Structure'

Material Spatial Feature (MSF): A dependent place feature that is material. - my house's backyard, frontyard. LOGIC: MSF(x) <--> SF(x) ^ mat(x)

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Material Spatial Feature to Spatial Feature
INCOMING STRUCTURAL RELATIONSHIPS
Generalization from Ductile Shear Zone to Material Spatial Feature
Generalization from Fault Zone to Material Spatial Feature
Generalization from Gradational Contact Zone to Material Spatial Feature

Maximum Calculation

Class in package 'Geologic Process'

A statistical value used for property value assignment, represents the expected or measured maximum value for property

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Maximum Calculation to Statistical Calculation

Mean Calculation

Class in package 'Geologic Process'

A statistical value used for property value assignment, represents the mean of multiple determination of the value for a property.

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Mean Calculation to Statistical Calculation

Member

Class in package 'Geologic Rock Body'

A lithostratigraphic rank.

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Member to Lithostratigraphic Unit
ATTRIBUTES
hasPart : Rock Body Part or Bed Multiplicity: [0..*],
isPartOf : Formation

Metamorphic Zone

Class in package 'Geologic Rock Body'

A geologic unit defined by observable effects of a metamorphic event in a rock body.

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Metamorphic Zone to Geologic Unit

Metamorphism

Class in package 'Geologic Process'

OUTGOING STRUCTURAL RELATIONSHIPS
⇦ Generalization from Metamorphism to Transformation
INCOMING STRUCTURAL RELATIONSHIPS
⇨ Generalization from Contact Metamorphism to Metamorphism

Metasomatism

Class in package 'Geologic Process'

Metasomatism: *is a metamorphic process by which the chemical composition of a rock or rock portion is altered in a pervasive manner and which involves the introduction and/or removal of chemical components as a result of the interaction of the rock with aqueous fluids (solutions). During metasomatism the rock remains in a solid state. (*V.A. ZharikovF, F, N.N. Pertsev, V.L. Rusinov, E. Callegari, and D.J. Fettes; 2017-01-02, **Metasomatism and metasomatic rocks**F,
Recommendations by the IUGS Subcommission on the Systematics of Metamorphic Rocks.

OUTGOING STRUCTURAL RELATIONSHIPS
⇦ Generalization from Metasomatism to Transformation

Meters

Class in package 'Top'

OUTGOING STRUCTURAL RELATIONSHIPS
⇦ Generalization from meters to Unit of Measure

Minimum Calculation

Class in package 'Geologic Process'

A statistical value used for property value assignment, represents the expected or measured minimum value for property

OUTGOING STRUCTURAL RELATIONSHIPS
⇦ Generalization from Minimum Calculation to Statistical Calculation

Morphologic Feature

Class in package 'Geologic Structure'

Materially-Dependent Morphological Feature (MF):
A feature that is not a part of its host, but characterized by the form or structure of the host:
Morphological features can have morphological properties e.g. orientation, thickness, fold profile, etc.
- smile or frown / lips
- mountain / planet surface (protrusion in the planet surface)
- graben and horst / planet surface (protrusion or depression in the planet surface caused by faulting)
- geological fold: rock body with a certain shape

MF(x) --> MDF (x) ^ exist y [hosts (y,x) ^ not partOf (x,y)]

OUTGOING STRUCTURAL RELATIONSHIPS
⇦ Generalization from Morphologic Feature to Inherent Feature
INCOMING STRUCTURAL RELATIONSHIPS
⇨ Generalization from Esker to Morphologic Feature
⇨ Generalization from Fold to Morphologic Feature

Observation

Class in package 'Geologic Process'

OUTGOING STRUCTURAL RELATIONSHIPS
⇦ Generalization from Observation to Determining Event

Orientation

Class in package 'Top'

INCOMING STRUCTURAL RELATIONSHIPS
⇨ Generalization from Endurant to Particular
⇨ Generalization from Amount Of Matter to Particular

INCOMING STRUCTURAL RELATIONSHIPS
Generalization from Perdurant to Particular
ATTRIBUTES
hasProperty : Property Multiplicity: [0..*],
determined-by : Determining Event
hasSetting : Situation Multiplicity: [0..*],
isSubjectOf : Representation Multiplicity: [0..*],

Outcrop

Class in package 'Geologic Rock Body'
An outcrop is a part of a rock body that is visible at the Earth Surface. The size of an outcrop depends on the intention of its identification, and can range from a specific contact point (e.g. a Global Stratigraphic Point) to and exposure that extends 1-10 m. An outcrop is unified by some particular observational intention to represent an aspect of a geologic unit. It is a kind of O&M sampling feature.

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Outcrop to Rock Body Part

Part Feature

Class in package 'Geologic Structure'
Relevant Part Feature (RPF)
A feature that is part of its host.
RPF(x) <--> MDF (x) ^ exist y [hosts (y,x) ^ partOf (x,y)]

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Part Feature to Feature
INCOMING STRUCTURAL RELATIONSHIPS
Generalization from Complex Feature to Part Feature
Generalization from Physical Boundary to Part Feature
ATTRIBUTES
colocatedWith : Physical Endurant Multiplicity: [1..*],

Pendant

Class in package 'Geologic Rock Body'
a mass of country rock that is entirely surrounded by an igneous intrusion such as a batholith or other pluton.

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Pendant to Rock Body Part

Percent

Class in package 'Top'
a unit of measure that can be associated with a numeric property value

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from percent to Unit of Measure

Perdurant

Class in package 'Top'
A perdurant persists (unfolds) in time and has only other perdurants as parts. Perdurants are also not fully present at any one time point - e.g. an earthquake or deposition process is never fully present except at its endpoint. In this sense perdurants only have temporal parts, not spatial parts. Exceptions are instantaneous temporal boundaries such as the start or end of an earthquake, which are fully present at a time. In contrast, endurants are always fully present and can have spatial parts. Things that are perdurants are processes, events, time regions, and their boundaries. Processes and events (i.e. occurrents) are the main types of perdurants, e.g. ground shaking or running, and earthquakes or runs, respectively. Process parts include sub-processes, sub-events, or temporal boundaries. Events can further have non-event perdurants as parts , such as the first few seconds of ground shaking or running, or the first few seconds of an earthquake or a run.
Time regions are also perdurants, as they only have temporal parts, that is, any part of a time region is another time region

(so they are homomerous). This differentiates time regions from occurrents: occurrents have parts that are only occurrents - they persist IN time, while time regions have parts that are only time regions - they persist AS time.

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Perdurant to Particular
INCOMING STRUCTURAL RELATIONSHIPS
Generalization from Time Region to Perdurant
Generalization from Event to Perdurant
Generalization from Process to Perdurant
ATTRIBUTES
hasPart : Perdurant Multiplicity: [0..*], Allow duplicates: 0, Is ordered: False)
hasReference : Particular

Period

Class in package 'Geologic Time'

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Period to Geologic Date Interval
ATTRIBUTES
hasPart : Epoch Multiplicity: [2..*],
isPartOf : Era

Physical Boundary

Class in package 'Geologic Structure'
Physical Boundary (PB):
A part of a physical object or amount of matter that touches the exterior in 3D space, either a point (e.g. table corner), a line (table edge), or a surface (e.g. table top)... possibly a volume.
PB(x) <--> RPF(x) ^ exists y,z [hosts(y,x) ^ partOf (x,y) ^ touches (x, complement(y))]

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Physical Boundary to Part Feature
INCOMING STRUCTURAL RELATIONSHIPS
Generalization from Rock Body Boundary to Physical Boundary

Physical Endurant

Class in package 'Top'
Physical endurants are physical things that occupy space, but are not the spatial region being occupied, e.g. geological formations. This includes holes in objects, which are not merely chunks of space - they are chunks of space in relation to a host object, which hosts the hole. So pores in rocks are physical endurants, because they exist relative to a rock, but the space bounded by some lat/long coords is not a physical endurant, it's just a chunk of space.

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Physical Endurant to Endurant
INCOMING STRUCTURAL RELATIONSHIPS
Generalization from Rock Body to Physical Endurant
Generalization from Amount Of Matter to Physical Endurant
Generalization from Physical Object to Physical Endurant
ATTRIBUTES
hasDirectSpatialLocation : Spatial Region
hasPart : Physical Endurant Multiplicity: [0..*],
hasReference : Physical Endurant Multiplicity: [0..1],

Physical Object

Class in package 'Top'

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Physical Object to Physical Endurant

INCOMING STRUCTURAL RELATIONSHIPS
Generalization from Geologic Unit to Physical Object
ATTRIBUTES
hasPart : Physical Object or Physical Feature Multiplicity: [0..*],
hasConstituent : Amount of Matter Multiplicity: [1..*],

Physical Void

Class in package 'Geologic Structure'
Physical Void (V):
An empty physical space in 3D. Distinct from abstract mathematical spaces, which include spaces made from various reference frames, including coordinate systems imposed on the earth (these are abstract imposed on real space).V(x) <--> IPF(x) ^ exists y [hosts-v (y,x)]

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Physical Void to Place Feature
INCOMING STRUCTURAL RELATIONSHIPS
Generalization from Gap to Physical Void
Generalization from Rock Body Void to Physical Void
Generalization from Hole to Physical Void

Place Feature

Class in package 'Geologic Structure'

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Place Feature to Immaterial Feature
INCOMING STRUCTURAL RELATIONSHIPS
Generalization from Physical Void to Place Feature

Planar Orientation

Class in package 'Top'

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Plasma to Fluid

Porespace

Class in package 'Geologic Structure'
Porespace (PS):
The gaps hosted within a rock body.
Formally: (after Hahman & Brodaric 2012):
PS (x) <--> G(x) ^ exists y [RB (y) ^ porespace (y) = x]

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Porespace to Rock Body Void

Process

Class in package 'Top'
In Basic Formal Ontology: An occurrent entity that exists in time by occurring or happening, has temporal (proper) parts, and always depends on some material (continuant) entity (Arp et al., 2015, p. 121; Notes in parenthesis () from Mustafa Jarrar https://www.slideshare.net/jarrar02/classifying-processes-and-basic-formal-ontology) Processes are not necessarily homeomeric or cumulative. " process is a series of events to produce a result" (https://wikidiff.com/event/process) "A process may also be defined as the workflows and sequence of events inherent in processes such as manufacturing, engineering and business processes." (https://en.wikipedia.org/wiki/Process_ontology)

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Process to Perdurant
INCOMING STRUCTURAL RELATIONSHIPS
Generalization from Geologic Process to Process
ATTRIBUTES
hasDirectTemporalLocation : Time Region

OUTGOING STRUCTURAL RELATIONSHIPS
hasIndirectSpatialLocation : Spatial Region
hasPart : Process Multiplicity: [0..*],
hasParticipant : Endurant Multiplicity: [1..*],
isConstituentOf : Event Multiplicity: [0..*],
hasReference : Process

Property

Class in package 'Top'

A property is considered an Endurant because it is wholly present at any particular time instant. A concept that specifies some aspect that inheres in instances of some Particular. Note that the value of the determiningEvent property on Property is used to specify metadata about how a property value is assigned

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Property to Endurant
INCOMING STRUCTURAL RELATIONSHIPS
Generalization from Unit of Measure to Property
Generalization from Grain Shape to Property
Generalization from Simple Uncertainty to Property
Generalization from State of Matter to Property
Generalization from RGB Colour Property to Property
Generalization from Orientation to Property
Generalization from Colour to Property
Generalization from Spatial Location to Property
ATTRIBUTES
isPropertyOf : Particular
hasValue : Property or DataType Multiplicity: [0..1],
hasProperty : Property Multiplicity: [0..*], A physical property may have other physical properties (rationale???) A physical property may have temporal properties, e.g. the property value might vary over time A physical property may have abstract properties that specify metadata about the property value asserted in a property instance, e.g. uncertainty.
hasPart : Multiplicity: [0],
isPartOf : Multiplicity: [0],

Pyroclastic Granular Material

Particles ejected during a volcanic eruption. (Jackson, 1997, p. 521). Clast whose origin is a direct result of volcanic process (excludes fragments in lava autobreccia) and has not been reworked by sedimentary processes (Gillespie and Styles 1999). Pyroclasts

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Pyroclastic Granular Material to Clastic Granular Material

Quartz

Example of a Mineral

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Quartz to Mineral

R

Class in package 'Top'

Red color band brightness value

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from R to RGB Colour Property

RGB Colour

Class in package 'Top'
A color specified by an R, G, B tuple.

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from RGB Colour to Colour
INCOMING STRUCTURAL RELATIONSHIPS
Generalization from RGB Red to RGB Colour
ATTRIBUTES
hasProperty : R or G or B Multiplicity: [3]

RGB Colour Property

Class in package 'Top'

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from RGB Colour Property to Property
INCOMING STRUCTURAL RELATIONSHIPS
Generalization from B to RGB Colour Property
Generalization from G to RGB Colour Property
Generalization from R to RGB Colour Property
ATTRIBUTES
hasDataValue : Number

RGB Red

Class in package 'Top'
A red color specified by an {R, G, B} tuple

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from RGB Red to RGB Colour
ATTRIBUTES
hasProperty : R = 255
hasProperty_ : G = 0
hasProperty__ : B = 0

Rhyolite

Example Class of Rock Material.

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Rhyolite to Rock Material
INCOMING STRUCTURAL RELATIONSHIPS
Realization from Rhyolite in X Formation to Rhyolite

Rhyolite in X Formation

Specific instance of Rhyolite, in a specific location and context.

OUTGOING STRUCTURAL RELATIONSHIPS
Realization from Rhyolite in X Formation to Rhyolite

Rock Body

Class in package 'Geologic Rock Body'
A any body composed Rock Material, either identified as a Geologic Unit or other object (sosa.Sample, ISO19156 SamplingFeature), or an amount of rock material not associated with an identified object, e.g. Dakota Sandstone Formation, or the sandstone of the Chalma basin.
Rock Body has at least one geneticProcess that is a Process. Each Rock Body particular has a preferred age assigned through the min and max NumAgeMa (numerical age in Ma) fields and the min and max StratAge fields. Strat ages are named time ordinal eras from the stratigraphic time scale selected for use in GSO. If the history of the Rock Body as a more detailed sequence of events is desired, it can be represented using the optional hasEventHistory property with a Geologic Event instance.

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Rock Body to Physical Endurant
INCOMING STRUCTURAL RELATIONSHIPS
Generalization from Geologic Unit to Rock Body
Generalization from Rock Body Part to Rock Body
Generalization from Rock Material to Rock Body
ATTRIBUTES
hasConstituent : Amount of Matter
hasPart : Rock Body Part or Geologic Unit Multiplicity: [0..*],

Rock Body Bottom

Class in package 'Geologic Structure'
Rock Body Bottom (RBB):
The outer and older surface of a rock body.
RBT (x) <--> RBS (x) ^ exists z forall y [partOf (y,z) ^ hosts (z,x) -> above (y,x) v partOf (y,x)]

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Rock Body Bottom to Rock Body Boundary

Rock Body Boundary

Class in package 'Geologic Structure'
Rock Body Boundary(RBB):
RBS is a physical boundary hosted by a rock body.
RBS (x) <--> SF (x) ^ exists y [RB (y) ^ hosts (y,x)]
The exterior-facing material of a rock body.

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Rock Body Boundary to Rock Body Part
Generalization from Rock Body Boundary to Physical Boundary
INCOMING STRUCTURAL RELATIONSHIPS
Generalization from Rock Body Bottom to Rock Body Boundary
Generalization from Rock Body Top to Rock Body Boundary
ATTRIBUTES
hostedBy : Rock Body

Rock Body Part

Class in package 'Geologic Rock Body'
A part of a rock body, either a geologic unit, amount of rock material, or Rock Body Surface.
If the part is a piece of another unit (e.g. xenolith in intrusion, block in melange), then the other unit can be found by inspecting the event history. Alternatively, a relation can be added to Geologic Unit to designate the original unit.
A rock body part may not be a stratigraphic part, i.e. a rock body part has 0 stratotype???

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Rock Body Part to Rock Body
INCOMING STRUCTURAL RELATIONSHIPS
Generalization from Rock Specimen to Rock Body Part
Generalization from Xenolith to Rock Body Part
Generalization from Rock Body Boundary to Rock Body Part
Generalization from Pendant to Rock Body Part
Generalization from Clast to Rock Body Part
Generalization from Fossil to Rock Body Part
Generalization from Lithosome to Rock Body Part
Generalization from Inclusion to Rock Body Part
Generalization from Outcrop to Rock Body Part
Generalization from Facies to Rock Body Part
Generalization from Stratigraphic Section to Rock Body Part
ATTRIBUTES
hasPart : Rock Body Part Multiplicity: [0..*],

OUTGOING STRUCTURAL RELATIONSHIPS
isPartOf : Rock Body Multiplicity: [1..*],
hasConstituent : Rock Material Multiplicity: [1..*],

Rock Body Top

Class in package 'Geologic Structure'
Rock Body Top (RBT):
The younger surface of a rock body.
RBT (x) <--> RBS (x) ^ exists z forall y [(partOf (y,z) ^ hosts (z,x)) -> (below (y,x) v partOf (y,x))]

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Rock Body Top to Rock Body Boundary

Rock Body Void

Class in package 'Geologic Structure'
Rock Body Void (RBV):
RBV is a gap within a Rock Body, or between rock bodies, or hole in the Rock Body.
RBV (x) <--> G(x) ^ exists y [hosts-v(y,x) ^ RB(x)]

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Rock Body Void to Physical Void
INCOMING STRUCTURAL RELATIONSHIPS
Generalization from Porespace to Rock Body Void

Rock Material

As an amount of matter, instances of rock material are located in space and time. From a philosophical point of view, if matter (including rock material) is abstract, as per GeoSciML, then there would be no physical or temporal manifestation of it. It is difficult to defend the position that matter does not physically exist in the world. This leads to absurdities, e.g. a geological unit having abstract parts (its rock materials) - this is like saying matter is the soul of the unit, not its physical constituent.
From a practical point of view, physical matter is always a constituent in some object, represented in this model as the other subtypes of Rock Body. Inclusion of a class for Rock Material allows description of material without association to an object.
In the GeoSciML model, participation of a Rock Material (named EarthMaterial in that model) as a constituent in a gsml.GeologicUnit has a role and proportion property.

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Rock Material to Amount Of Matter
Generalization from Rock Material to Rock Body
INCOMING STRUCTURAL RELATIONSHIPS
Generalization from Rhyolite to Rock Material
ATTRIBUTES
hasPart : Rock Body Part Multiplicity: [0..*],
isPartOf : Rock Body Multiplicity: [0],
hasConstituent : Granular Material or Mineral or Element or Glass Multiplicity: [1..*],
isConstituentOf : Geologic Unit or Rock Body Part Multiplicity: [0..*],

Rock Specimen

Class in package 'Geologic Rock Body'
isSampleOf is a subproperty of isPartOf

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Rock Specimen to Rock Body Part
ATTRIBUTES
isSampleOf : Rock Body

Simple Uncertainty

Class in package 'Top'

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Simple Uncertainty to Property
ATTRIBUTES
hasDataValue : Number

Situation

Class in package 'Top'

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Situation to Endurant
INCOMING STRUCTURAL RELATIONSHIPS
Generalization from Geologic Setting to Situation
ATTRIBUTES
isSettingFor : Particular Multiplicity: [0..*], Allow duplicates: 0, Is ordered: False)
hasIndirectSpatialLocation : Spatial Region

Solid

Class in package 'Top'

state of matter

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Solid to State of Matter

Spatial Feature

Class in package 'Geologic Structure'

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Spatial Feature to Feature
INCOMING STRUCTURAL RELATIONSHIPS
Generalization from Immaterial Feature to Spatial Feature
Generalization from Material Spatial Feature to Spatial Feature

Spatial Location

Class in package 'Top'

A physical property that spacifies the position of an entity relative to some spatial reference system

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Subangular to Grain Shape

Statistical Calculation

Class in package 'Geologic Process'

Specification of statistics associated with a measured value, e.g. minimum, maximum, mean, mode, standard deviation.

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Statistical Calculation to Calculation
INCOMING STRUCTURAL RELATIONSHIPS
Generalization from First Standard Deviation Calculation to Statistical Calculation
Generalization from Maximum Calculation to Statistical Calculation
Generalization from Mean Calculation to Statistical Calculation
Generalization from Minimum Calculation to Statistical Calculation

Stratigraphic Point

Class in package 'Geologic Structure'

A spatially restricted part of a Contact feature, typically located by a point location. Could be thought of as an instance of a Contact, or a sample of a Contact.

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Stratigraphic Point to Contact
INCOMING STRUCTURAL RELATIONSHIPS
Generalization from GSSP to Stratigraphic Point

Stratigraphic Section

Class in package 'Geologic Rock Body'

A rock body that represents a transect through a sequence of stratified rocks. Although a section is typically observed and described along a linear traverse on the EarthSurface or in a borehole, the description applies to the rock volume in the vicinity of that transect. Operationally, a section might be constructed by a linked set of traverses in the same area, or using segments from multiple boreholes in the same area.

The stratigraphic section concept is in contrast to the cross-section or profile concept, which represents a typically (but not necessarily) vertical mapping horizon surface through a rock body used for depicting geologic relationships. A cross section would be a kind of geologic surface in this model.

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Stratigraphic Section to Rock Body Part
INCOMING STRUCTURAL RELATIONSHIPS
Generalization from Stratotype to Stratigraphic Section

Stratotype

Class in package 'Geologic Rock Body'

A particular stratigraphic section used a reference (prototype) to define a stratigraphic unit; a stratotype section might contain a Stratigraphic Point that is the reference for a particular Contact.

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Stratotype to Stratigraphic Section
ATTRIBUTES
isReferenceFor : Physical Endurant Multiplicity: [1..*],
hasReference : Private Multiplicity: [0],

SubtractiveProcess

Class in package 'Geologic Process'

A process that removes matter from part of an Earth Model.

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from SubtractiveProcess to Geologic Process
INCOMING STRUCTURAL RELATIONSHIPS
Generalization from Erosion to SubtractiveProcess

Supergroup

Class in package 'Geologic Rock Body'

http://www.stratigraphy.org/upload/bak/litho.htm

The term "supergroup" may be used for several associated groups or for associated groups and formations with significant lithologic properties in common.

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Supergroup to Lithostratigraphic Unit
ATTRIBUTES
hasPart : Group or Formation or Complex Multiplicity: [2..*],

Tectonic Unit

Class in package 'Geologic Rock Body'

A lithotectonic unit refers to “an assemblage of rocks that is unified on the basis of structural or deformational features, mutual relations, origin, or historical evolution, and the contained material may be igneous, sedimentary or metamorphic”

(Neuendorf et al. 2011 Neuendorf, K.K.E., Mehl Jr., J.P. & Jackson, J.A., 2011: Glossary of Geology, 5th ed., revised. Alexandria, VA, American Geological Institute, 800 pp.)As a start point. Need more general def.Tectonic Unit

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Tectonic Unit to Geologic Unit
INCOMING STRUCTURAL RELATIONSHIPS
Generalization from Deformation Unit to Tectonic Unit

Time Instant

Class in package 'Top'

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Time Instant to Time Region
INCOMING STRUCTURAL RELATIONSHIPS
Generalization from Geologic Time Date to Time Instant

Time Interval

Class in package 'Top'

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Time Interval to Time Region
INCOMING STRUCTURAL RELATIONSHIPS
Generalization from Geologic TIme Interval to Time Interval
7 Generalization from Geologic Date Interval to Time Interval
Generalization from Geologic Time Scale to Time Interval

Time Region

Class in package 'Top'

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Time Region to Perdurant
INCOMING STRUCTURAL RELATIONSHIPS
Generalization from Time Interval to Time Region
Generalization from Time Instant to Time Region
ATTRIBUTES
isTemporalLocationFor : not Time Region Multiplicity: [0..*],
hasPart : Time Region Multiplicity: [0..*],
hasReference : Particular

Transformation

Class in package 'Geologic Process'

Process that changes the characteristics of materials within the model space. Includes metamorphism, metasomatism, alteration, weathering

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Transformation to Geologic Process
INCOMING STRUCTURAL RELATIONSHIPS
Generalization from Metamorphism to Transformation
Generalization from Metasomatism to Transformation

Unit of Measure

Class in package 'Top'

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Unit of Measure to Property
INCOMING STRUCTURAL RELATIONSHIPS
Generalization from percent to Unit of Measure
Generalization from meters to Unit of Measure
Generalization from Ma to Unit of Measure

Volcanic Glass

Glass formed by rapid cooling of lava

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Volcanic Glass to Glass

X Formation

Class in package 'Geologic Rock Body'

example instance of Formation

OUTGOING STRUCTURAL RELATIONSHIPS
Realization from X Formation to Formation

Xenolith

Class in package 'Geologic Rock Body'

a rock fragment that becomes enveloped in a larger rock during the latter's development and solidification. In geology, the term xenolith is almost exclusively used to describe inclusions in igneous rock during magma emplacement and eruption. https://en.wikipedia.org/wiki/Xenolith

OUTGOING STRUCTURAL RELATIONSHIPS
Generalization from Xenolith to Rock Body Part