

# **Definition of the CRMba**

An extension of CIDOC CRM to support buildings archaeology documentation

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# 1.1 Introduction

Historic buildings are, in most cases, the result of a series of matter addition and removal due to construction and destruction activities that modified their appearance over the various historical periods. The identification of these processes, together with the analysis of the different building techniques and the materials utilized over its existence, provides archaeologists with an understanding of the continuity and discontinuity of matter and activities on a built structure. All these strands of information can be used to produce a detailed understanding of the development of any building, whether standing or in ruins, and to identify significant phases of the monument's appearance throughout the centuries.

After an accurate analysis of specific metadata standards for the documentation of the built heritage, a complex mapping between them was carried to understand whether these standards enable to record the semantics of the building's components. The result of the mapping (Ronzino et al. 2012) demonstrated that such standards, although very rich in their structure, fail in describing the completeness of information about the building and the relationships among its parts and with the whole. Moreover, the mapping between the Archaeological Monument/Archaeological Complex (MA/CA) form - the most complete among the standards analysed - and the CIDOC CRM, highlighted the need to add more specialized concepts to the latter to describe the very complex structure of the buildings, especially as concerns the analytical description of the asset (static and functional components) and the relationship among its parts.

## 1.1.1 Scope

The CRMba is an ontology and RDF Schema to encode metadata about the documentation of archaeological buildings (Ronzino 2015, Ronzino et al. 2015). The model was conceived to support the process of recording the evidences and the discontinuities of matter on archaeological buildings, in order to identify the evolution of the structure throughout the centuries and to record the relationships between each of the building components among them and with the building as a whole. It aims at expressing the semantic relations of the stratigraphic units of a standing building, taking into account the stratigraphic analysis theory of the standing buildings (Brogiolo 1988, Parenti 2002, Schuller 2002, Morriss 2004).

The goal of the CRMba conceptual model is to provide support to:

- understand the building structure and its development;
- recognize the use of a building and how it evolved over the years;
- identify the various phases of the building as a result of construction, transformation, modification and reuse;
- support the investigation and interpretation of the material evidence in the standing structures;
- understand the correlation between parts of a buildings and whole;
- recognize, analyse and interpret the stratigraphy of standing structures and of ruins;
- support the dating process through the identification of the Stratigraphic Relationship (SR) between the various Stratigraphic Units (SU), which can be inferred by the identification of the Stratigraphic Interfaces (SI).

The model is built on the same principles of the CIDOC CRM. As in CRM, indeed, the semantics of the building are rendered as properties between two classes. The model reuses, when appropriate, parts of the CIDOC CRM classes and properties, and refers to other CRM extensions that were developed to ensure the completeness of documentation. In particular, the CRMba model incorporates parts of the CRMgeo, a detailed model of generic spatio-temporal topology and geometric description (Doerr & Hiebel 2013); parts of CRMsci, a model for scientific observation, measurements and processed data in descriptive and empirical sciences (such as biology, geology, geography, cultural heritage conservation, etc.) and CRMarcheo, a model developed for the documentation of archaeological excavations.



Fig.1 The CRMba conceptual model

## 1.1.2 Status

CRMba is the result of a research carried out in the framework of the ARIADNE project and is part of the outcome of the PhD thesis by Paola Ronzino with title “CRMba. A CRM extension for buildings archaeology information modelling” (Ronzino 2015). The model is the result of a collaboration between PIN (Italy), FORTH (Greece) and the Central Institute for Cataloguing and Documentation (Italy). The first need that the model attempts to meet is to create a common ground for the integration of archaeological records about the documentation of buildings archaeology, from raw data to official documentation produced according to national and institutional standards. This document describes a community model which has been approved by CRM SIG to be formally and methodologically compatible with CIDOC CRM. However, in a broader sense, it is always open to any possible integration and addition that may become necessary as a result of its practical use on real archaeological problems on a large scale. The model is intended to be maintained and promoted as an international standard. CRMba has been harmonized with CRMarchaeo to allow the analysis of the stratifications of buildings or part of buildings that are found, either connected or unconnected, in subsurface stratifications.

## 1.1.3 Naming Convention

All the classes declared were given both a name and an identifier constructed according to the conventions used in the CIDOC CRM model. For classes that identifier consists of the letter B followed by a number. Resulting properties were also given a name and an identifier, constructed according to the same conventions. That identifier consists of the letters BP followed by a number, which in turn is followed by the letter “i” every time the property is mentioned “backwards”, i.e., from target to domain (inverse link). “B” and “BP” do not have any other meaning. They correspond respectively to letters “E” and “P” in the CIDOC CRM naming conventions, where “E” originally meant “entity” (although the CIDOC CRM “entities” are now consistently called “classes”), and “P” means “property”. Whenever CIDOC CRM classes are used in our model, they are named by the name they have in the original CIDOC CRM. CRMsci classes and properties are referred with their respective names, classes denoted by S and properties by O, CRMarchaeo classes and properties are referred with their respective names, classes denoted by A and properties by AP.

## 1.2 Class and Property hierarchies

The CIDOC CRM model declares no “attributes” at all (except implicitly in its “scope notes” for classes), but regards any information element as a “property” (or “relationship”) between two classes. The semantics are therefore rendered as properties, according to the same principles as the CIDOC CRM model.

Although they do not provide comprehensive definitions, compact mono hierarchical presentations of the class and property IsA hierarchies have been found to significantly aid in the comprehension and navigation of the model, and are therefore provided below.

The class hierarchy presented below has the following format:

- Each line begins with a unique class identifier, consisting of a number preceded by the appropriate letter “E”, “B”, “A”, “S”
- A series of hyphens (“-”) follows the unique class identifier, indicating the hierarchical position of the class in the IsA hierarchy.
- The English name of the class appears to the right of the hyphens.
- The index is ordered by hierarchical level, in a “depth first” manner, from the smaller to the larger sub hierarchies.
- Classes that appear in more than one position in the class hierarchy as a result of multiple inheritance are shown in an italic typeface.

## 1.2.1 Buildings archaeology model class hierarchy, aligned with portions from the CRMarchaeo, CRMsci, and the CIDOC CRM class hierarchies

This class hierarchy lists:

- all classes declared in CRMba
- all classes declared in CRMsci, CRMarchaeo, CRMinf and CIDOC CRM that are declared as superclasses of classes declared in the CRMba model,
- all classes declared in CRMsci, CRMarchaeo, CRMinf or CIDOC CRM that are either domain or range for a property declared in the CRMba,
- all classes declared in CRMsci, CRMarchaeo, CRMinf and CIDOC CRM that are either domain or range for a property declared in CRMsci, CRMarchaeo, CRMinf or CIDOC CRM that is declared as superproperty of a property declared in the CRMba,
- all classes declared in CRMsci, CRMarchaeo, CRMinf and CIDOC CRM that are either domain or range for a property that is part of a complete path of which a property declared in CRMba is declared to be a shortcut.

E1	CRM Entity
E2	- Temporal Entity
E3	- - Condition State
E5	- - - Event
E7	- - - - Activity
E11	- - - - - Modification
E12	- - - - - - Production
E79	- - - - - - Part Addition
E80	- - - - - - Part Removal
E77	- Persistent Item
E70	- - Thing
E18	- - - - Physical Thing
S20	- - - - - Physical Feature
E26	- - - - - Physical Feature
A8	- - - - - - Stratigraphic Unit
A2	- - - - - - - Stratigraphic Volume Unit
B5	- - - - - - - - Stratigraphic Building Unit
A3	- - - - - - - Stratigraphic Interface
E19	- - - - - Physical Object
E22	- - - - - - Man-Made Object
E24	- - - - - Physical Man-Made Thing
B1	- - - - - - Built Work
B2	- - - - - - - Morphologic Building section
B3	- - - - - - - - Filled Morphologic Building Section
E52	- Time-Span
E53	- Place
S20	- - Physical Feature
B4	- - - Empty Morphological Building Section
E92	- Spacetime Volume

## 1.2.2 Buildings archaeology model property hierarchy, aligned with portions from the CRMarchaeo, CRMsci, and the CIDOC CRM property hierarchies

This property hierarchy lists:

- all properties declared in CRMba,
- all properties declared in CRMsci, CRMarchaeo, CRMinf, and CIDOC CRM that are declared as superproperties of properties declared in CRMba,
- all properties declared in CRMsci, CRMarchaeo, CRMinf and CIDOC CRM that are part of a complete path of which a property declared in CRMba, is declared to be a shortcut.

Property id	Property Name	Entity – Domain	Entity - Range
BP1	is section of (has section)	B2 Morphological Building Section	B1 Built Work
BP2	is constituent of (is constituted by)	B5 Stratigraphic Building Unit	B1 Built Work
BP3	is spatial temporary equal to	E92 Spacetime Volume	E92 Spacetime Volume
BP4	terminates the constituency (constituency is terminated by)	E80 Part removal	B2 Morphological Building Section
BP5	initiates the constituency (constituency is initiated by)	E79 Part addition	B2 Morphological Building Section
BP8	is adjacent to	B2 Morphological Building Section	B2 Morphological Building Section
BP11	is connected to	B2 Morphological Building Section	B2 Morphological Building Section
BP11.1	in the mode of	BP11 is connected to	E55 Type
BP11.2	is connected through	BP11 is connected to	E24 Physical Man Made Thing
BP13	used specific object (is specific object used by)	E12 Production	B5 Stratigraphic Building Unit
BP14	re-used specific object (was specific object re-used by)	E12 Production	B5 Stratigraphic Building Unit



## 1.3 Buildings archaeology model Class Declarations

The classes of CRMba are comprehensively declared in this section using the following format:

- Class names are presented as headings in bold face, preceded by the class's unique identifier;
- The line "Subclass of:" declares the superclass of the class from which it inherits properties;
- The line "Superclass of:" is a cross-reference to the subclasses of this class;
- The line "Scope note:" contains the textual definition of the concept the class represents;
- The line "Examples:" contains a bulleted list of examples of instances of this class.
- The line "Properties:" declares the list of the class's properties;
- Each property is represented by its unique identifier, its forward name, and the range class that it links to, separated by colons;
- Inherited properties are not represented;
- Properties of properties, if they exist, are provided indented and in parentheses beneath their respective domain property.

### **B1 Built Work**

Subclass of: E92 Spacetime Volume

E24 Physical Man-Made Thing

Superclass of: B2 Morphological Building Section

Scope note: This class comprises instances of man-made things such as freestanding buildings, components of buildings, and complexes of buildings. It refers to man-made environments, typically large enough for humans to enter, serving a practical purpose, being relatively permanent and stable (AAT). Instances of built works are composed of parts that share an aspect of role, which often perform a distinct function.

Examples: The Bishop's Palace  
The ruins of Loropéni  
The Coliseum

Properties: BP1 has section (is section of): B2 Morphological Building Section  
BP2 is constituted by (is constituent of): B5 Stratigraphic Building Unit  
P108 was produced by (has produced): E12 Production  
P16 was used for (used specific object): E7 Activity  
P103 was intended for (was intention of): E55 Type

### **B2 Morphological Building Section**

Subclass of: B1 Built Work

Superclass of: B3 Filled Morphological Building Section

Scope note: This class comprises instances of man-made things that are considered functional units for the whole building (e.g. rooms, foundations, roof, and so forth). A B2 is a geometric feature with volume and is a Spacetime Volume (E92). A B2 is composed of (P46) parts that are completely filled with matter (B3 Filled Morphological Building Section), which confines (AP12) empty spaces (B4 Empty Morphological Building Section) that are the result of the intentional disposition of a set of B3.

Examples: The western wall of the Cathedral  
The corner tower  
The battlements of the palace perimeter

Properties: BP1 is section of (has section): B1 Built Work  
BP4 constituency is terminated by (terminates the constituency): E80 Part Removal  
BP5 constituency is initiated by (initiates the constituency): E79 Part addition  
BP11 is connected to: B2 Morphological Building Section

BP11.2 is connected through: B2 Morphological Building Section  
P108 was produced by (has produced): E12 Production  
P16 was used for (used specific object): E7 Activity  
P46 is composed of (forms part of): B3 Filled Morphological Building Section

### **B3 Filled Morphological Building Section**

Subclass of: E24 Physical Man-Made Thing  
B2 Morphological Building Section

Scope note: This class comprises instances of man-made things that are completely filled with matter. Instances of Filled Morphological Building Section are components of the functional units of a built work. These elements like walls, floors and ceilings have properties such as dimensions, material etc. The intentional disposition of a set of B3 defines portions of space that are completely void, e.g. a window, a doorway and so forth.

Examples: The ionic columns of the portico  
The walls that surround a room

Properties: P46 forms part of (is composed of): B2 Morphological Building Section  
AP12 confines (is confined by): BP4 Empty Morphological Building Section

### **B4 Empty Morphological Building Section**

Subclass of: S20 Physical Feature

Scope note: This class comprises identifiable features that are physically attached to particular physical objects. Instances of B4 Empty Morphological Building Section are components of the functional units that form a built work.  
Example of B4 are the empty spaces that are formed by their surrounding walls, floors and ceiling. Empty spaces are fundamental elements in modelling environments like BIM that need to have explicit space objects where the spaces are formed by the surrounding objects (Underwood et al. 2009). Instances of B4 are portions of the space resulting from the intentional disposition in the space of a set of Filled Morphological Building Sections. The void space must be intentionally obtained to serve a function for the building.

Examples: The intercolumniation of a portico  
The Gate of Felicity of Topkapı Palace  
The *compluvium* of the roof of a Roman Domus  
The portico of the Temple of Ercole Vincitore (B1) is composed of columns (B3) that confine (AP12) the intercolumniation (B4)

Properties: AP12 is confined by (confines): BP3 Filled Morphological Building Section

### **B5 Stratigraphic Building Unit**

Subclass of: A2 Stratigraphic Volume Unit

Scope note: This class comprises instances of physical things that represents the minimal construction unit of a built work. The B5 Stratigraphic Building Unit is a constituent part of a B2 Morphological Building Section. The Stratigraphic Building Unit (B5) represents a single evidence of human activity intentionally performed on the building: e.g. the presence of mortar, vestments or any of the discontinuities of matter that can be observed on a wall surface. The term constituency is used within the model with the meaning: “the status of being a constituent part”.  
Instances of Stratigraphic Building Unit are, for example, a single wall or the various architectonic components that constitute the Morphologic Building Section.

Examples: The fresco decoration of the great hall

Properties: BP2 is constituent of (is constituted by): B1 Built Work  
AP2 is confined by (confines): A3 Stratigraphic Interface  
BP13 is specific object used by (used specific object): E12 Production  
AP11 has physical relations (is physical relation of): B5 Stratigraphic Building Unit

## 1.4 Buildings archaeology model Properties Declarations

The properties of the CRM Buildings Archaeology information modelling are comprehensively declared in this section using the following format:

- Property names are presented as headings in bold face, preceded by unique property identifiers;
- The line “Domain:” declares the class for which the property is defined;
- The line “Range:” declares the class to which the property points, or that provides the values for the property;
- The line “Quantification:” declares the possible number of occurrences for domain and range class instances for the property. Possible values are: 1:many, many:many, many:1;
- The line “Scope note:” contains the textual definition of the concept the property represents.

### **BP1 is section of (has section)**

Domain: B2 Morphological Building Section

Range: B1 Built Work

Quantification: many to one (0,n:0,1)

Scope note: This property is used to link the Morphological Building Sections that are part of a Built Work

Examples: The great hall (BP1 is section of) the Bishop’s Palace

### **BP2 is constituent of (is constituted by)**

Domain: B5 Stratigraphic Building Unit

Range: B1 Built Work

Quantification: many to one (0,n:0,1)

Scope note: This property describes the relation between a Morphological Building Section (e.g. a wall) and any Stratigraphic Building Section. When the SBU and the MBS are equal we can use the shortcut: B5 SBU (BP2 is constituent of) B1 Built Work.

Examples: The fresco of the great hall (BP2 is constituent of) the northern wall

### **BP3 is spatial temporary equal to**

Domain: E92 Spacetime Volume

Range: E92 Spacetime Volume

Quantification: many to many (0,n:0,n)

Scope note: This property is used to relate the Spacetime Volume of two entities (Morphological Building Units and Stratigraphic Building Section). When the two STV overlap, the two entities are equal.

Examples: The STV of the plaster that completely covers the wall surface (BP3 is spatial temporary equal to) the STV of the masonry.

**BP4 terminates the constituency (constituency was terminated by)**

Domain: E80 Part removal

Range: B2 Morphological Building Section

Quantification: many to many (0,n:0,n)

Scope note: This property is used to describe the constituency (being part of) of a Stratigraphic Building Section with a Filled Morphological Building Section. The constituency ends when an entity (FMBS) is diminished by matter.

Examples: The removal of the fresco from the northern wall (BP4 terminates the constituency) of the fresco to the wall.

**BP5 initiates the constituency (constituency was initiated by)**

Domain: E79 Part addition

Range: B2 Morphological Building Section

Quantification: many to many (0,n:0,n)

Scope note: This property is used to describe the beginning of the constituency of a Stratigraphic Building Unit with a Morphological Building Section. This starts when substance is added to a Morphological Building Unit.

Examples: The painting of the fresco on the northern wall (BP5 initiates the constituency) of the painting to the wall.

**BP11 is connected to**

Domain: B2 Morphological Building Section

Range: B2 Morphological Building Section

Quantification: one to many (0,n:0,1)

Scope note: This property identifies the instance of B2 Morphological Building Section which is connected to another instance of B2 Morphological Building Section. The instance of E24 Physical Man Made Thing through which the connection between the two instances of B2 Morphological Building Section is made, can be recorded using the property BP11.2 is connected through.

Examples: The great hall (B2) *is connected to* the sacristy (B2).

Properties: BP11.1 in the mode of: E55 Type

**BP11.2 is connected through**

Domain: BP11 is connected to  
Range: E24 Physical Man Made Thing

Quantification: one to many (0,n:0,1)

Scope note: This property identifies the instance of E24 Physical Man Made Thing through which the connection between the two instances of B2 Morphological Building Section is made.

Examples: The great hall (B2) is connected to (B11) the sacristy (B2) *is connected through* the corridor (E24).

**BP13 used specific object (was specific object used by)**

Domain: E12 Production  
Range: B5 Stratigraphic Building Unit

Quantification: many to many (0,n:0,n)

Scope note: This property is used to describe an instance of a physical object that is used in the production of new substance that constitutes the Morphological Building Section (i.e. a Stratigraphic Building Section)

Examples: The construction of the new façade (BP13 used specific object) the staircase.

**BP14 re-used specific object (was specific object re-used by)**

Domain: E12 Production  
Range: B5 Stratigraphic Building Unit

Quantification: many to many (0,n:0,n)

Scope note: This property is used to describe an instance of a physical object that is re-used in the production of new substance that constitutes the Morphological Building Section (i.e. a Stratigraphic Building Section)

Examples: The stones of the Roman theatre (BP14 was specific object re-used by) the construction of the fountain.

**BP15 is equal to**

Domain: B5 Stratigraphic Building Unit  
Range: B3 Filled Morphological Building Section

Quantification: many to many (0,n:0,n)

Scope note: This property is used to relate a Stratigraphic Building Section with a Morphological Building Section when the former is equal to the latter.

Examples: The northern wall (BP 15 is equal to) the SBU “northern wall”.



## 1.5 Referred to CIDOC CRM Classes and properties

Since Buildings Archaeology Model refers to and reuses, wherever appropriate, large parts of the CIDOC Conceptual Reference Model, this section provides a comprehensive list of all constructs used from CIDOC CRM, together with their definitions following the CIDOC CRM version 6.2.1, October 2015 *maintained by CIDOC CRM - SIG*.

### 1.5.1 CIDOC CRM Classes

#### E5 Event

Subclass of: [E4](#) Period

Superclass of: [E7](#) Activity

[E63](#) Beginning of Existence

[E64](#) End of Existence

Scope note: This class comprises changes of states in cultural, social or physical systems, regardless of scale, brought about by a series or group of coherent physical, cultural, technological or legal phenomena. Such changes of state will affect instances of [E77](#) Persistent Item or its subclasses.

The distinction between an [E5](#) Event and an [E4](#) Period is partly a question of the scale of observation. Viewed at a coarse level of detail, an [E5](#) Event is an ‘instantaneous’ change of state. At a fine level, the [E5](#) Event can be analysed into its component phenomena within a space and time frame, and as such can be seen as an [E4](#) Period. The reverse is not necessarily the case: not all instances of [E4](#) Period give rise to a noteworthy change of state.

Examples:

- the birth of Cleopatra ([E67](#))
- the destruction of Herculaneum by volcanic eruption in 79 AD ([E6](#))
- World War II ([E7](#))
- the Battle of Stalingrad ([E7](#))
- the Yalta Conference ([E7](#))
- my birthday celebration 28-6-1995 ([E7](#))
- the falling of a tile from my roof last Sunday
- the CIDOC Conference 2003 ([E7](#))

In First Order Logic:

$E5(x) \supset E4(x)$

Properties:

[P11](#) *had participant (participated in)*: [E39](#) Actor

[P12](#) *occurred in the presence of (was present at)*: [E77](#) Persistent Item

#### E7 Activity

Subclass of: [E5](#) Event

Superclass of: [E8](#) Acquisition

[E9](#) Move

[E10](#) Transfer of Custody

[E11](#) Modification

[E13](#) Attribute Assignment

[E65](#) Creation

[E66](#) Formation

[E85](#) Joining

[E86](#) Leaving

[E87](#) Curation Activity



Scope note: This class comprises actions intentionally carried out by instances of E39 Actor that result in changes of state in the cultural, social, or physical systems documented.

This notion includes complex, composite and long-lasting actions such as the building of a settlement or a war, as well as simple, short-lived actions such as the opening of a door.

Examples:

- the Battle of Stalingrad
- the Yalta Conference
- my birthday celebration 28-6-1995
- the writing of “Faust” by Goethe (E65)
- the formation of the Bauhaus 1919 (E66)
- calling the place identified by TGN ‘7017998’ ‘Quyunjig’ by the people of Iraq
- Kira Weber working in glass art from 1984 to 1993
- Kira Weber working in oil and pastel painting from 1993

In First Order Logic:

$E7(x) \supset E5(x)$

Properties:

[P14](#) carried out by (performed): [E39](#) Actor  
(P14.1 in the role of: [E55](#) Type)

[P15](#) was influenced by (influenced): [E1](#) CRM Entity

[P16](#) used specific object (was used for): [E70](#) Thing  
(P16.1 mode of use: [E55](#) Type)

[P17](#) was motivated by (motivated): [E1](#) CRM Entity

[P19](#) was intended use of (was made for): [E71](#) Man-Made Thing  
(P19.1 mode of use: [E55](#) Type)

[P20](#) had specific purpose (was purpose of): [E5](#) Event

[P21](#) had general purpose (was purpose of): [E55](#) Type

[P32](#) used general technique (was technique of): [E55](#) Type

[P33](#) used specific technique (was used by): [E29](#) Design or Procedure

[P125](#) used object of type (was type of object used in): [E55](#) Type

[P134](#) continued (was continued by): [E7](#) Activity

## **E12 Production**

Subclass of: [E11](#) Modification  
[E63](#) Beginning of Existence

Scope note: This class comprises activities that are designed to, and succeed in, creating one or more new items.

It specializes the notion of modification into production. The decision as to whether or not an object is regarded as new is context sensitive. Normally, items are considered “new” if there is no obvious overall similarity between them and the consumed items and material used in their production. In other cases, an item is considered “new” because it becomes relevant to documentation by a modification. For example, the scribbling of a name on a potsherd may make it a voting token. The original potsherd may not be worth documenting, in contrast to the inscribed one.

This entity can be collective: the printing of a thousand books, for example, would normally be considered a single event.

An event should also be documented using E81 Transformation if it results in the destruction of one or more objects and the simultaneous production of others using parts or material from the originals. In this case, the new items have separate identities and matter is preserved, but identity is not.

Examples:

- the construction of the SS Great Britain
- the first casting of the Little Mermaid from the harbour of Copenhagen
- Rembrandt's creating of the seventh state of his etching "Woman sitting half dressed beside a stove", 1658, identified by Bartsch Number 197 (E12,E65,E81)

In First Order Logic:

$E12(x) \supset E11(x)$

$E12(x) \supset E63(x)$

Properties:

[P108](#) has produced (was produced by): [E24](#) Physical Man-Made Thing

### **E18 Physical Thing**

Subclass of: [E72](#) Legal Object

[E92](#) Spacetime Volume

Superclass of: [E19](#) Physical Object

[E24](#) Physical Man-Made Thing

[E26](#) Physical Feature

Scope Note: This class comprises all persistent physical items with a relatively stable form, man-made or natural.

Depending on the existence of natural boundaries of such things, the CRM distinguishes the instances of E19 Physical Object from instances of E26 Physical Feature, such as holes, rivers, pieces of land etc. Most instances of E19 Physical Object can be moved (if not too heavy), whereas features are integral to the surrounding matter.

An instance of E18 Physical Thing occupies not only a particular geometric space, but in the course of its existence it also forms a trajectory through spacetime, which occupies a real, that is phenomenal, volume in spacetime. We include in the occupied space the space filled by the matter of the physical thing and all its inner spaces, such as the interior of a box. Physical things consisting of aggregations of physically unconnected objects, such as a set of chessmen, occupy a number of individually contiguous spacetime volumes equal to the number of unconnected objects that constitute the set.

We model E18 Physical Thing to be a subclass of E72 Legal Object and of E92 Spacetime volume. The latter is intended as a phenomenal spacetime volume as defined in CRMgeo (Doerr and Hiebel 2013). By virtue of this multiple inheritance we can discuss the physical extent of an E18 Physical Thing without representing each instance of it together with an instance of its associated spacetime volume. This model combines two quite different kinds of substance: an instance of E18 Physical Thing is matter while a spacetime volume is an aggregation of points in spacetime. However, the real spatiotemporal extent of an instance of E18 Physical Thing is regarded to be unique to it, due to all its details and fuzziness; its identity and existence depends uniquely on the identity of the instance of E18 Physical Thing. Therefore this multiple inheritance is unambiguous and effective and furthermore corresponds to the intuitions of natural language.

The CIDOC CRM is generally not concerned with amounts of matter in fluid or gaseous states.

Examples:

- the Cullinan Diamond (E19)
- the cave "Ideon Andron" in Crete (E26)
- the Mona Lisa (E22)

In First Order Logic:

$E18(x) \supset E72(x)$

$E18(x) \supset E92(x)$

Properties:

[P44](#) has condition (is condition of): [E3](#) Condition State

[P45](#) consists of (is incorporated in): [E57](#) Material

[P46](#) is composed of (forms part of): [E18](#) Physical Thing

[P49](#) has former or current keeper (is former or current keeper of): [E39](#) Actor

[P50](#) has current keeper (is current keeper of): [E39](#) Actor

[P51](#) has former or current owner (is former or current owner of): [E39](#) Actor

[P52](#) has current owner (is current owner of): [E39](#) Actor

[P53](#) has former or current location (is former or current location of): [E53](#) Place

[P58](#) has section definition (defines section): [E46](#) Section Definition

[P59](#) has section (is located on or within): [E53](#) Place

[P128](#) carries (is carried by): [E90](#) Symbolic Object

[P156](#) occupies (is occupied by): [E53](#) Place

### **E24 Physical Man-Made Thing**

Subclass of: [E18](#) Physical Thing

[E71](#) Man-Made Thing

Superclass of: [E22](#) Man-Made Object

[E25](#) Man-Made Feature

[E78](#) Collection

Scope Note: This class comprises all persistent physical items that are purposely created by human activity.

This class comprises man-made objects, such as a swords, and man-made features, such as rock art. No assumptions are made as to the extent of modification required to justify regarding an object as man-made. For example, a “cup and ring” carving on bedrock is regarded as instance of E24 Physical Man-Made Thing.

Examples:

- the Forth Railway Bridge (E22)
- the Channel Tunnel (E25)
- the Historical Collection of the Museum Benaki in Athens (E78)

In First Order Logic:

$E24(x) \supset E18(x)$

$E24(x) \supset E71(x)$

Properties:

[P62](#) depicts (is depicted by): [E1](#) CRM Entity

(P62.1 mode of depiction: [E55](#) Type)

[P65](#) shows visual item (is shown by): [E36](#) Visual Item

### **E52 Time-Span**

Subclass of: [E1](#) CRM Entity

Scope note: This class comprises abstract temporal extents, in the sense of Galilean physics, having a beginning, an end and a duration.

Time Span has no other semantic connotations. Time-Spans are used to define the temporal extent of instances of E4 Period, E5 Event and any other phenomena valid for a certain time. An E52 Time-Span may be identified by one or more instances of E49 Time Appellation.

Since our knowledge of history is imperfect, instances of E52 Time-Span can best be considered as approximations of the actual Time-Spans of temporal entities. The properties of E52 Time-Span are intended to allow these approximations to be expressed precisely. An extreme case of approximation, might, for example, define an E52 Time-Span having unknown beginning, end and duration. Used as a common E52 Time-Span for two events, it would nevertheless define them as being simultaneous, even if nothing else was known.

Automatic processing and querying of instances of E52 Time-Span is facilitated if data can be parsed into an E61 Time Primitive.

Examples:

- 1961
- From 12-17-1993 to 12-8-1996
- 14h30 – 16h22 4<sup>th</sup> July 1945
- 9.30 am 1.1.1999 to 2.00 pm 1.1.1999
- duration of the Ming Dynasty

In First Order Logic:

$E52(x) \supset E1(x)$

Properties:

[P78](#) is identified by (identifies): [E49](#) Time Appellation

[P79](#) beginning is qualified by: [E62](#) String

[P80](#) end is qualified by: [E62](#) String

[P81](#) ongoing throughout: [E61](#) Time Primitive

[P82](#) at some time within: [E61](#) Time Primitive

[P83](#) had at least duration (was minimum duration of): [E54](#) Dimension

[P84](#) had at most duration (was maximum duration of): [E54](#) Dimension

[P86](#) falls within (contains): [E52](#) Time-Span

### **E53 Place**

Subclass of: [E1](#) CRM Entity

Scope note:

This class comprises extents in space, in particular on the surface of the earth, in the pure sense of physics: independent from temporal phenomena and matter.

The instances of E53 Place are usually determined by reference to the position of “immobile” objects such as buildings, cities, mountains, rivers, or dedicated geodetic marks. A Place can be determined by combining a frame of reference and a location with respect to this frame. It may be identified by one or more instances of E44 Place Appellation.

It is sometimes argued that instances of E53 Place are best identified by global coordinates or absolute reference systems. However, relative references are often more relevant in the context of cultural documentation and tend to be more precise. In particular, we are often interested in position in relation to large, mobile objects, such as ships. For example, the Place at which Nelson died is known with reference to a large mobile object – H.M.S Victory. A resolution of this Place in terms of absolute coordinates would require knowledge of the movements of the vessel and the precise time of death, either of which may be revised, and the result would lack historical and cultural relevance.

Any object can serve as a frame of reference for E53 Place determination. The model foresees the notion of a "section" of an E19 Physical Object as a valid E53 Place determination.

Examples:

- the extent of the UK in the year 2003
- the position of the hallmark on the inside of my wedding ring
- the place referred to in the phrase: “Fish collected at three miles north of the confluence of the Arve and the Rhone”

- here -> <-

In First Order Logic:

$E53(x) \supset E1(x)$

Properties:

[P87](#) is identified by (identifies): [E44](#) Place Appellation

[P89](#) falls within (contains): [E53](#) Place

[P121](#) overlaps with: [E53](#) Place

[P122](#) borders with: [E53](#) Place

[P157](#) is at rest relative to (provides reference space for): [E18](#) Physical Thing

[P168](#) place is defined by (defines place) : [E94](#) Space Primitive

### **E55 Type**

Subclass of: [E28](#) Conceptual Object

Superclass of: [E56](#) Language

[E57](#) Material

[E58](#) Measurement Unit

Scope note:

This class comprises concepts denoted by terms from thesauri and controlled vocabularies used to characterize and classify instances of CRM classes. Instances of E55 Type represent concepts in contrast to instances of E41 Appellation which are used to name instances of CRM classes.

E55 Type is the CRM's interface to domain specific ontologies and thesauri. These can be represented in the CRM as subclasses of E55 Type, forming hierarchies of terms, i.e. instances of E55 Type linked via P127 has broader term (has narrower term). Such hierarchies may be extended with additional properties.

Examples:

- weight, length, depth [types of E54]
- portrait, sketch, animation [types of E38]
- French, English, German [E56]
- excellent, good, poor [types of E3]
- Ford Model T, chop stick [types of E22]
- cave, doline, scratch [types of E26]
- poem, short story [types of E33]
- wedding, earthquake, skirmish [types of E5]

In First Order Logic:

$E55(x) \supset E28(x)$

Properties:

[P127](#) has broader term (has narrower term): [E55](#) Type

[P150](#) defines typical parts of(define typical wholes for): [E55](#) Type

### **E92 Spacetime Volume**

Subclass of: [E1](#) CRM Entity

Superclass of: [E4](#) Period

[E18](#) Physical Thing

[E93](#) Presence

Scope note:

This class comprises 4 dimensional point sets (volumes) in physical spacetime regardless its true geometric form. They may derive their identity from being the extent of a material phenomenon or from being the interpretation of an expression defining an extent in spacetime. Intersections of instances of E92 Spacetime Volume, Place and Timespan are also regarded as instances of E92 Spacetime Volume. An instance of E92 Spacetime Volume is either contiguous or composed of a finite number of contiguous subsets. Its boundaries may be fuzzy due to the

properties of the phenomena it derives from or due to the limited precision up to which defining expression can be identified with a real extent in spacetime. The duration of existence of an instance of a spacetime volume is trivially its projection on time.

Examples:

- the spacetime Volume of the Event of Ceasars murder
- the spacetime Volume where and when the carbon 14 dating of the "Schoeninger Speer II" in 1996 took place
- the spatio-temporal trajectory of the H.M.S. Victory from its building to its actual location
- the spacetime volume defined by a polygon approximating the Danube river flood in Austria between 6<sup>th</sup> and 9<sup>th</sup> of August 2002

In First Order Logic:

$$E92(x) \supset E1(x)$$

Properties:

[P10](#) falls within (contains): [E92](#) Spacetime Volume

[P132](#) overlaps with: [E92](#) Spacetime Volume

[P133](#) is separated from: [E92](#) Spacetime Volume

[P160](#) has temporal projection: [E52](#) Time-Span

[P161](#) has spatial projection: [E53](#) Place

## 1.5.2 CIDOC CRM Properties

This section contains the complete definitions of the properties of the CIDOC CRM Conceptual Reference Model version 6.2.1 October 2015 referred to by BRMba.

### P2 has type (is type of)

Domain: [E1](#) CRM Entity

Range: [E55](#) Type

Superproperty of: [E1](#) CRM Entity.[P137](#) exemplifies (is exemplified by):E55 Type

Quantification: many to many (0,n:0,n)

Scope note: This property allows sub typing of CRM entities - a form of specialisation – through the use of a terminological hierarchy, or thesaurus.

The CRM is intended to focus on the high-level entities and relationships needed to describe data structures. Consequently, it does not specialise entities any further than is required for this immediate purpose. However, entities in the isA hierarchy of the CRM may be specialised into any number of sub entities, which can be defined in the E55 Type hierarchy. E51 Contact Point, for example, may be specialised into “e-mail address”, “telephone number”, “post office box”, “URL” etc. none of which figures explicitly in the CRM hierarchy. Sub typing obviously requires consistency between the meaning of the terms assigned and the more general intent of the CRM entity in question.

Examples:

“enquiries@cidoc-crm.org” (E51) *has type* e-mail address (E55)

In First Order Logic:

$$P2(x,y) \supset E1(x)$$
$$P2(x,y) \supset E55(y)$$

### P4 has time-span (is time-span of)

Domain: [E2](#) Temporal Entity

Range: [E52](#) Time-Span

Quantification: many to one, necessary, dependent (1,1:1,n)

Scope note: This property describes the temporal confinement of an instance of an E2 Temporal Entity.

The related E52 Time-Span is understood as the real Time-Span during which the phenomena were active, which make up the temporal entity instance. It does not convey any other meaning than a positioning on the “time-line” of chronology. The Time-Span in turn is approximated by a set of dates (E61 Time Primitive). A temporal entity can have in reality only one Time-Span, but there may exist alternative opinions about it, which we would express by assigning multiple Time-Spans. Related temporal entities may share a Time-Span. Time-Spans may have completely unknown dates but other descriptions by which we can infer knowledge.

Examples:

- the Yalta Conference (E7) *has time-span* Yalta Conference time-span (E52)

In First Order Logic:

$$P4(x,y) \supset E2(x)$$
$$P4(x,y) \supset E52(y)$$

### P20 had specific purpose (was purpose of)

Domain: [E7](#) Activity

Range: [E5](#) Event

Quantification: many to many (0,n:0,n)

Scope note: This property identifies the relationship between a preparatory activity and the event it is intended to be preparation for.

This includes activities, orders and other organisational actions, taken in preparation for other activities or events.

*P20 had specific purpose (was purpose of)* implies that an activity succeeded in achieving its aim. If it does not succeed, such as the setting of a trap that did not catch anything, one may document the unrealized intention using *P21 had general purpose (was purpose of):E55 Type* and/or *P33 used specific technique (was used by): E29 Design or Procedure*.

Examples:

- Van Eyck's pigment grinding in 1432 (E7) *had specific purpose* the painting of the Ghent altar piece (E12)

In First Order Logic:

$P21(x,y) \supset E7(x)$

$P21(x,y) \supset E55(y)$

### **P46 is composed of (forms part of)**

Domain: [E18 Physical Thing](#)

Range: [E18 Physical Thing](#)

Subproperty of: [E92 Spacetime Volume](#). [P132](#) overlaps with: [E92 Spacetime Volume](#)

Superproperty of: [E19 Physical Object](#). [P56](#) bears feature (is found on): [E26 Physical Feature](#)

Quantification: many to many (0,n:0,n)

Scope note: This property allows instances of E18 Physical Thing to be analysed into component elements.

Component elements, since they are themselves instances of E18 Physical Thing, may be further analysed into sub-components, thereby creating a hierarchy of part decomposition. An instance of E18 Physical Thing may be shared between multiple wholes, for example two buildings may share a common wall. This property does not specify when and for how long a component element resided in the respective whole. If a component is not part of a whole from the beginning of existence or until the end of existence of the whole, the classes E79 Part Addition and E90 Part Removal can be used to document when a component became part of a particular whole and/or when it stopped being a part of it. For the time-span of being part of the respective whole, the component is completely contained in the place the whole occupies.

This property is intended to describe specific components that are individually documented, rather than general aspects. Overall descriptions of the structure of an instance of E18 Physical Thing are captured by the *P3 has note* property.

The instances of E57 Material of which an item of E18 Physical Thing is composed should be documented using *P45 consists of (is incorporated in)*.

Examples:

- the Royal carriage (E22) *forms part of* the Royal train (E22)
- the "Hog's Back" (E24) *forms part of* the "Fosseway" (E24)

In First Order Logic:

$P46(x,y) \supset E18(x)$

$P46(x,y) \supset E18(y)$

$P46(x,y) \supset P132(x,y)$

$P46(x,y) \supset (\exists uzw)[E93(u) \wedge P166(x,u) \wedge E52(z) \wedge P164(u,z) \wedge E93(w) \wedge P166(y,w) \wedge$

$P164(w,z) \wedge P10(w,u)]$



### **P101 had as general use (was use of)**

Domain: [E70](#) Thing  
Range: [E55](#) Type  
Quantification: many to many (0,n:0,n)

Scope note: This property links an instance of E70 Thing to an E55 Type of usage.

It allows the relationship between particular things, both physical and immaterial, and general methods and techniques of use to be documented. Thus it can be asserted that a baseball bat had a general use for sport and a specific use for threatening people during the Great Train Robbery.

Examples:

- Tony Gill's Ford Mustang (E22) *had as general use* transportation (E55)

In First Order Logic:

$P101(x,y) \supset E70(x)$   
 $P101(x,y) \supset E55(y)$

### **P103 was intended for (was intention of)**

Domain: [E71](#) Man-Made Thing  
Range: [E55](#) Type  
Quantification: many to many (0,n:0,n)

Scope note: This property links an instance of E71 Man-Made Thing to an E55 Type of usage.

It creates a property between specific man-made things, both physical and immaterial, to Types of intended methods and techniques of use. Note: A link between specific man-made things and a specific use activity should be expressed using *P19 was intended use of (was made for)*.

Examples:

- this plate (E22) *was intended for* being destroyed at wedding reception (E55)

In First Order Logic:

$P103(x,y) \supset E71(x)$   
 $P103(x,y) \supset E55(y)$

### **P108 has produced (was produced by)**

Domain: [E12](#) Production  
Range: [E24](#) Physical Man-Made Thing  
Subproperty of: [E11](#) Modification. [P31](#) has modified (was modified by): [E24](#) Physical Man-Made Thing

[E63](#) Beginning of Existence. [P92](#) brought into existence (was brought into existence by): [E77](#) Persistent Item  
Quantification: one to many, necessary, dependent (1,n:1,1)

Scope note: This property identifies the E24 Physical Man-Made Thing that came into existence as a result of an E12 Production.

The identity of an instance of E24 Physical Man-Made Thing is not defined by its matter, but by its existence as a subject of documentation. An E12 Production can result in the creation of multiple instances of E24 Physical Man-Made Thing.

Examples:

- The building of Rome (E12) *has produced* The Colosseum (E22)

In First Order Logic:

$P108(x,y) \supset E12(x)$   
 $P108(x,y) \supset E24(y)$   
 $P108(x,y) \supset P31(x,y)$   
 $P108(x,y) \supset P92(x,y)$

## 1.6 Referred to Scientific Observation Model Classes and properties

Since Buildings Archaeology model refers to and reuses, wherever appropriate, parts of Scientific Observation Model this section provides a comprehensive list of all constructs used from that model, together with their definitions following the CRM*sci*, together with their definitions following version 1.2 maintained by FORTH.

### 1.6.1 Scientific Observation Model Classes

This section contains the complete definitions of the classes of the Scientific Observation Model referred to by Excavation Model

#### S20 Physical Feature

Subclass of:

[E18](#) Physical Thing  
[E53](#) Place

Superclass of:

[E25](#) Man-Made Feature  
[E27](#) Site  
[S22](#) Segment of Matter

Equivalent to:

[E26](#) Physical Feature (CIDOC-CRM)

Scope Note:

This class comprises identifiable features that are physically attached in an integral way to particular physical objects. An instance of [S20](#) Physical Feature also represents the place it occupies with respect to the surrounding matter. More precisely, it is the maximal real volume in space that an instance of [S20](#) Physical Feature is occupying during its lifetime with respect to the default reference space relative to which the feature is at rest. In cases of features on or in the surface of earth, the default reference is typically fixed to the closer environment of the tectonic plate or sea floor. In cases of features on mobile objects, the reference space is typically fixed to the geometry of the bearing object.

Instances of [E26](#) Physical Feature share many of the attributes of instances of [E19](#) Physical Object. They may have a one-, two- or three-dimensional geometric extent, but there are no natural borders that separate them completely in an objective way from the carrier objects. For example, a doorway is a feature but the door itself, being attached by hinges, is not.

Instances of [E26](#) Physical Feature can be features in a narrower sense, such as scratches, holes, reliefs, surface colors, reflection zones in an opal crystal or a density change in a piece of wood. In the wider sense, they are portions of particular objects with partially imaginary borders, such as the core of the Earth, an area of property on the surface of the Earth, a landscape or the head of a contiguous marble statue. They can be measured and dated, and it is sometimes possible to state who or what is or was responsible for them. They cannot be separated from the carrier object, but a segment of the carrier object may be identified (or sometimes removed) carrying the complete feature.

This definition coincides with the definition of "fiat objects" (Smith & Varzi, 2000, pp.401- 420), with the exception of aggregates of "bona fide objects".

Examples:

- the temple in Abu Simbel before its removal, which was carved out of solid rock
- Albrecht Durer's signature on his painting of Charles the Great
- the damage to the nose of the Great Sphinx in Giza
- Michael Jackson's nose prior to plastic surgery

## 1.7 Referred to Excavation Model Classes and properties

Since Buildings Archaeology model refers to and reuses, wherever appropriate, parts of CRMarchaeo Model this section provides a comprehensive list of all constructs used from that model, together with their definitions following the CRMarchaeo, together with their definitions following version 1.4 maintained by PIN.

### 1.7.1 Excavation Model Classes

This section contains the complete definitions of the classes of the Excavation Model referred to by CRMba.

#### A2 Stratigraphic Volume Unit

Subclass of: [A8 Stratigraphic Unit](#)

Superclass of:

Scope Note: This class comprises connected portions of terrain or other solid structure on, in, or under the surface of earth or seafloor exhibiting some homogeneity of structure or substance and completely bounded by surfaces or discontinuities in substance or structure with respect to other portions of the terrain or surfaces of objects/finds.

An instance of [A8 Stratigraphic Unit](#) may contain physical objects. The internal continuity and the boundaries of an instance of [A8 Stratigraphic Unit](#) should be of a kind that can be attributed to a single genesis event or process and have the potential to be observed.

One genesis event may have created more than one SU. An instance of [A8 Stratigraphic Unit](#) is regarded to exist as long as a part of its matter is still in place with respect to a surrounding reference space such that its spatial features can be associated with effects of the genesis process of interest. Normally at least one of the surfaces (such as the lower one) from its genesis event will remain during its existence.

This also implies that a certain degree of coherent (“conformal”) deformation is tolerable within its time-span of existence. Therefore the place an instance of [A8 Stratigraphic Unit](#) occupies can be uniquely identified with respect to the surrounding reference space of archaeological interest.

Examples:

The stratigraphic deposit unit number (2) of Figure 5 representing the filling of a post hole

#### A3 Stratigraphic Interface

Subclass of: [A8 Stratigraphic Unit](#)

Superclass of:

Scope Note: This class comprises coherent parts of the boundary surface, which appears as the result of a stratigraphic genesis event or process. The interface marks the extreme limit of the effect of a genesis or modification event, and indicates in particular where the effect of this event ended. Each event of creation/destruction of a deposition layer implies the creation of new interfaces. Thus there are two main types of interface: those that are surfaces of strata (that can be directly related to the corresponding stratum via the [AP12](#) confines property), and those that are only surfaces, formed by the removal or destruction of existing stratifications.

Examples:

The Stratigraphic Interface number [19] confines the number (2) Stratigraphic Volume Unit, in Figure 5

Properties:

[AP12](#) confines (is confined by): [A2](#) Stratigraphic Volume Unit

## **A6 Group Declaration Event**

Subclass of: [S5](#) Inference Making

Superclass of:

Scope Note: This class comprises activities resulting in the assignment of a common attribute to several Stratigraphic Units. This may be due to an archaeologists interpretation of them being part of one physical thing, like postholes being part of one building.

Examples:

The excavator declared the post holes [7] and [8] in Figure 4 to be part of one building

Properties:

[AP16](#) assigned attribute to (was attributed by): [A8](#) Stratigraphic Unit  
[P141](#) assigned: [E18](#) Physical Thing

## **A7 Embedding**

Subclass of: [S16](#) State

Superclass of:

Scope Note: This class comprises the states of instances of [E18](#) Physical Things of being partially or completely embedded at a particular position with relative stability in one or more [A2](#) Stratigraphic Volume Units. Normally, an embedding is expected having been stable from the time of generation on of the first [A2](#) Stratigraphic Volume Unit that surrounds it. However, it may also be due to later intrusion. As an empirical fact, the expert may only be able to decide that a particular embedding is not recent, i.e., has been persisting for longer than the activity that encountered it. This class can be used to document the fact of embedding generally with respect to the surrounding matter or more specifically with respect to a more precise position within this matter. It further allows for specifying temporal bounds for which a particular embedding has been existing as specified according to evidence.

Examples:

The excavator declared the post holes [7] and [8] in Figure 4 to be part of one building

Properties:

[AP17](#) is found by (found): [S19](#) Encounter Event  
[AP18](#) is embedding of (is embedded): [E18](#) Physical Thing A  
[P19](#) is embedding in (contains embedding): [A2](#) Stratigraphic Volume Unit  
[AP20](#) is embedding at (contains): [E53](#) Place

## **A8 Stratigraphic Unit**

Subclass of: [S20](#) Physical Feature

Superclass of:

Scope Note: This class comprises [S20](#) Physical Features that are either [A2](#) Stratigraphic Volume Units or [A3](#) Stratigraphic Interfaces

Examples:

The excavator declared the post holes [7] and [8] in Figure 4 to be part of one building

Properties:

[AP11](#) has physical relation (is physical relation of): [A8](#) Stratigraphic Unit  
[AP15](#) is or contains remains of (is or has remains contained in): [E18](#) Physical Thing

## 1.7.2 Excavation Model Properties

This section contains the complete definitions of the properties of the Excavation Model version 1.4 referred to by CRMba.

### AP11 has physical relation (is physical relation of)

Domain: [A8](#) Stratigraphic Unit

Range: [A8](#) Stratigraphic Unit

Subproperty of:

Superproperty of:

Quantification: one to many (0,n:0,1)

Scope note: This property identifies the physical relationship between two [A8](#) Stratigraphic Units. The type of physical relationships found between stratigraphic units in archaeological documentation is documented through the property [AP 11.1](#) has type

Examples:

- fills
- is filled by
- cuts
- is cut by
- is bonded with
- butted
- jointed
- above
- below

In First Order Logic:

Properties: [AP11.1](#) has type: [E55](#) Type

### AP15 is or contains remains of (is or has remains contained in)

Domain: [A8](#) Stratigraphic Unit

Range: [E22](#) Physical Thing

Subproperty of:

Superproperty of:

Quantification: one to many (0,n:0,1)

Scope note: This property associates an [E18](#) Physical Thing that is found within an [A8](#) Stratigraphic Unit with the stratigraphic unit. This property is a shortcut for the fully articulated path from [E18](#) Physical Thing through [A7](#) Embedding to [A8](#) Stratigraphic Unit.

Examples:

In First Order Logic:

Properties:

### AP16 assigned attribute to (was attributed by)

Domain: [A6](#) Group Declaration Event

Range: [A8](#) Stratigraphic Unit

Subproperties: [E13](#) Attribute Assignment. [P140](#) assigned attribute to (was attributed by): [E1](#) CRM Entity

Superproperty of:

Quantification: one to many (0,n:0,1)

Scope note: This property indicates the Stratigraphic Unit that was assigned by an [A6](#) Group Declaration Event.

Examples:

In First Order Logic:

Properties:

**AP18 is embedding of (is embedded)**

Domain: [A7](#) Embedding

Range: [E18](#) Physical Thing

Subproperty of:

Superproperty of:

Quantification: one to many (0,n:0,1)

Scope note: This property identifies the [E18](#) Physical Thing that is contained in an [A7](#) Embedding.

Examples:

In First Order Logic:

Properties:

**AP19 is embedding in (contains embedding)**

Domain: [A7](#) Embedding

Range: [A2](#) Stratigraphic Volume Unit

Subproperty of:

Superproperty of:

Quantification: one to many (0,n:0,1)

Scope note: This property identifies the [A2](#) Stratigraphic Volume Unit that contains the [A7](#) Embedding.

Examples:

In First Order Logic:

Properties: