



Megalithism Representation in CIDOC-CRM

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Abstract. The definition of Megalithism is found in specialized and academic works, on Archaeology and Prehistory, as well as in generalist dictionaries, glossaries and encyclopedias. However we are not aware of formal definitions specifically to this particular domain. This paper presents an under development proposal of Megalithism Knowledge Representation that relies on CIDOC CRM to represent the monuments and concepts of European Megalithism. It includes the granularity required to represent this form of architecture: from composite parts to single elements, such as standing stones. A structured way for representing such definitions is required in order to guide future knowledge extraction from Megalithism reports.

Keywords: Megalithism · Knowledge representation · CIDOC CRM

1 Introduction

The epistemological root of the concept of Megalithism (from the Greek *me-gas*, large, and *lithos*, stone) is based on the dimensions and nature of the monuments. Although its apparently simple definition, the heterogeneity and intrinsic polymorphism of Megalithism stands out, emerging a heterogeneous and polymorphic reading of this cultural manifestation. This emerging reading reflects the multiple actors that shaped the phenomenon through construction, reconstruction or even the interaction between monuments and regions, or even through the multiplicity of archaeological interpretations.

The information treated by History and Archaeology is made up of fragments that allow the portrayal of a past reality and, as such, allow the construction of

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multiple narratives [3]. Thus, archaeological information systems must be able to deal with subjectivity, multivocality, temporality and uncertainty. As stated in [3], “without a data model capable of adequately describing not only the archaeological data contained within records, but the archaeological processes used to generate records, any database is limited in terms of its capabilities and suitability for reporting, assessment and analysis and ultimately its suitability as an archive” [3, p. 489].

Under the principle of protection by archaeological record, there is an evolution in the *outputs* of archaeological works that have become increasingly larger, more complex and mostly digital. In this context of proliferation of the digitization of Cultural Heritage, new challenges have risen, the range of applications has become more comprehensive and the number of actors interested in obtaining and sharing knowledge related to heritage has increased. In this context, digital sharing of Cultural Heritage information implies challenges such as: interoperability, structuring and transforming data into information, information into knowledge and knowledge into application, etc. [12], and ideally, to adapt to FAIR Principles. Knowledge-based approaches, structured with Linked Open Data (LOD) concepts and ontologies, are recognized as a basis for efficient solutions [12]. However, many institutions and/or research groups continue to independently develop their databases and management application, isolated from the others, already existing, producing a fragmented accumulation of data [8], leaning to create “data silos”.

In this paper, we propose a CIDOC CRM extension, regarding the representation of megalithic monuments, having in mind the usual aspects included in archaeology grey literature. There are other proposals of CIDOC CRM extensions for archaeological works. In [6], the authors present the components of archaeological buildings, with a focus on construction techniques and materials, describing the visual representations, the buildings’ chronology and provenance of buildings. In [9] the authors propose extensions, referring to archaeological experiments mainly concerning digital analysis of virtual samples. We are not aware of an extension specific to the definition of megalithic monuments with the objective of organize usual official reports content. The goal is to set up the basis for sharing the rich existing data about Megalithism in a principled way, including the granularity needed to represent this form of architecture: from composite parts to single elements, such as standing stones.

In Europe megalithism appears in prehistoric and protohistoric chronology, but similar symbolic expressions, funerary and non-funerary, appear in non-coeval periods in other regions of the globe. In archaeological literature, the origins of Megalithism is a long-term debate, associated with “oriental missionaries”, “segmentary societies”, “environmental changes” and, in some regions, mimetical behavior [4]. “This vast array of explanations reflect how difficult is to identify the historical reasons laying beyond such a wide phenomenon were global and local features are combine in a multitude of ways” [4].

The rest of the paper is organised as follows. Section 2 introduces the CIDOC CRM model and Sect. 3 presents our proposal, followed of a discussion in Sect. 4.

2 CIDOC CRM

The CIDOC CRM (*standard* ISO21127) is a continuously developing *Conceptual Reference Model* (CRM) that provides formal frameworks for describing implicit and explicit concepts and relationships used in cultural heritage documentation [8]. This initiative is managed by the *International Committee for Documentation* of the *International Council of Museums* and has the participation of an extensive community of volunteers who meet annually with the aim of integrating and linking data on Cultural Heritage from the basic relationships between objects and events.

According to [5], CIDOC CRM encourages information sharing and is based on the epistemological idea of phases of the academic/scientific process:

- collect and organize evidence (observation and primary sources);
- link facts through relationships;
- interpretation of evidence—contextualize and build hypotheses;
- display results—publication;

As a base, CRM describes general characteristics of objects (identifiers, typology, title, material, dimension, notes), but also the history of the object through events and activities (transfer of custody, location – former and current, origin, discovery, attribution of classifications, measurements) as well as relationships between objects and parts of objects (bibliography, composition, likeness) and their representations (drawings, paintings, inscriptions) [11].

This high-level *framework* is seen as a common, modular and extensible semantic standard, providing the chance to develop extensions for various purposes.

3 Defining Megalithism

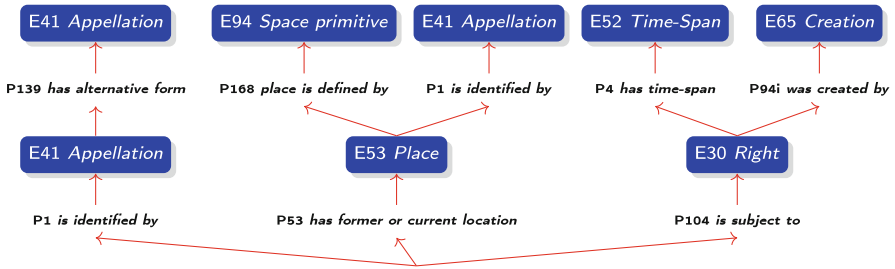
Our proposal is an extension to concepts related to Megalithism. Figure 1 illustrates the concept of Megalithic monument (MM) defined on the basis of CIDOC CRM elements. We refer to Version 7.1.1 of CIDOC CRM. Due to space limitations, we present only the description of some classes and relations. The concept MM is a subclass of (*E24 Physical Human Made Thing* and also of its subclass *E22 Human Made Object*), which is defined along with other specific relations. We pictured relations regarding its identification (appellation), location, legal protection (rights), type, and composition. There are several other relevant relations such as association with artifacts and others.

In [6], a CIDOC CRM extension is proposed specifically to incorporate components of archaeological buildings, they define (B1 Built Work), our concept for MM may be integrated as its subclass. Other extensions for archaeology will not be discussed in this paper, but on later future work.

The idea is that these concepts, presented in more principled ways, may help to find and compare monuments. This structure is also intended to guide

information extraction from the megalithic sites reports that allow description of the monuments.

Next we detail some of these concepts and relations. We will use as an example one specific monument, “Anta Grande da Comenda da Igreja” (Fig. 2), a well-preserved dolmen (*anta*) located in Alentejo (Portugal) known by its dimensions relative to its neighbours, with a long history of archaeological works and other publications [7].



Megalithic Monument

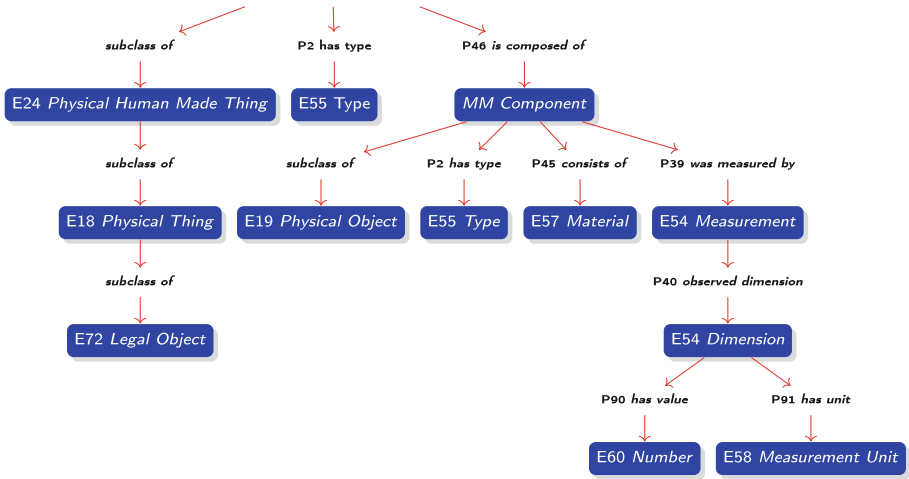


Fig. 1. Megalithic monument description elements

Toponymy. An MM is identified by its appellation, which may have alternative forms. It might be a code assigned to the monument by certain institutions, such as the CNS (Portuguese national archaeological site code) code. The monument we are using as an example is identified by appellation “Anta Grande da Comenda da Igreja”. It has the CNS code 616 and alternative names “Anta Grande da Herdade da Igreja” and “Anta Grande da Herdade da Comenda”.

Type. 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. Examples of the architecture type are “Dólmen”, “Menir” and “Recinto Megalítico”, but others can be added.

The MM “Anta Grande da Comenda da Igreja”, for example, has the types “funerary megalithism”, “Anta/Dólmen” and “Megalitismo Eborense”. In Portugal, *Anta* and *Dólmen* are mostly considered as synonyms and *Megalitismo Eborense* is a concept used only among Portuguese archaeologists to describe a geographically limited stylistic variant of funerary Megalithism found in central Alentejo.

Legal Protection. The relation (P104 is subject to) (E30 Right) specifies the legal protection of a monument. The MM “Anta Grande da Comenda da Igreja” is subject to a protection (right) that was created by a protection event (Creation). This protection has a time span of time from 20-01-1936 to the present day.

Location. The relation (P56 has former or current location) (E53 Place) allows the introduction of general information related to the location, such as (E41 Appellations) and (E94 Space primitive) that may contain spacial coordinates and may be linked to Geoinformation systems.

In our example, “Anta Grande da Comenda da Igreja” (P168 place is defined by) the (E94 Space Primitive):

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<gml:Point srsName='‘urn:ogc:def:crs:EPSG::4326’'>
  <gml:pos>38.757998,-8.203181</gml:pos>
</gml:Point>
```

Component. The record of an MM may include one or more MM architectural components which, as far as it is concerned, may also be composed of one or more elements. This is expressed by the relation (P46 is composed of) (MM Component), which is a new concept, subclass of (E19 Physical Object). While, from the CRM perspective, the definition of megalithic monument does not differ much from other man made artifacts, being composed by MM components is the key to its differentiation. The basic MM component is denominated megalith, and it is usually understood as a single piece of stone roughly shaped or in definite shapes for symbolic purposes. Different arrangements of megaliths (including single stones) are taken here as MM Components.

Types of MM components are chambers, corridors, orthostats, etc. In this way, the configuration designed allows the registration of MM components with their respective descriptions, but also, if necessary, the registration of each standing stone. Regarding [6], mentioned earlier, this would be related to (B2 Morphological Building Section).

In our example, “Anta Grande da Comenda da Igreja” (P46 is composed of) a part that (P2 has type) “Chamber”, that (P45 consists of) (E57 Material) Granite and has (P40 observed dimension) diameter which (P90 has value) of 4,5 (E60 Number) in meters (Measurement Unit), as in Fig. 2.

Besides the concepts described here, there are some other relevant classes and relations associated to the extension for MM being developed, such as the relation with archaeological works undertaken on the monuments and the elements found, such as artifacts (E22 Human Made Objects). Description of artifacts are important to allow users to filter the monuments by the typology of artifacts associated with them. For example, filtering all monuments with geometrics or a certain ceramic typology, trace of reuse.

Subclasses of Megalithic Monument. Another key aspect in the definition of megalithism are its specializations or subclasses. There are defined types of monuments which are related to a unique or isolated standing stone or megalith, such as the concept of a Menhir. Other sub concepts or type of monuments include multiple stones, which may be aligned, or placed in circles (Cromlechs, see Fig. 3). A Dolmen (Fig. 2) is an example of a more complex megalithic monument in which stones create a chamber, often considered to be used as a tomb or burial chamber. With the proposed model we intend to formalize all these concepts and their specific compositions, trying to push forward supra-regional studies.

4 Discussion

This extension proposal allows for the identification of the main elements and relations that define and characterize an MM. It is intended to better describe monuments in order to help finding and comparing them. It will also serve as a basis for the organization of current reported knowledge constituted of non-structured data.

As introduced early in the paper, in the literature, we find other proposals of CIDOC CRM extensions in the area of archaeology. In [9] the authors also propose CIDOC CRM extensions, referring to archaeological experiments mainly concerning digital analysis of virtual samples. In [6], a CIDOC CRM extension is proposed specifically to incorporate components of archaeological buildings, which in some aspects are related to our proposal. However, they deal mainly with construction techniques, materials, visual representations, chronology and provenance of the buildings. For megalithic site description, construction techniques were very basic and are mostly unknown.

Differently from these other works, our main focus here is to describe Megalithism concepts. Our approach focuses on relevant elements for allowing better search and comparison, and considers the usual components of official reports of megalithic sites studies (prospections, excavations, environmental assessments) and their particular relations with subclasses of monuments.

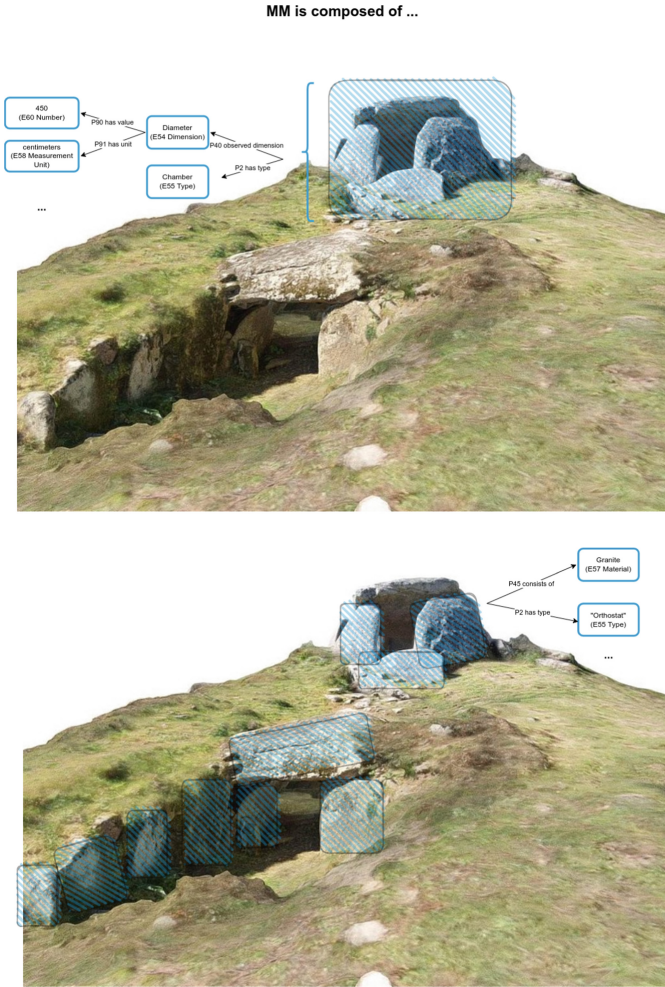


Fig. 2. Anta Grande da Comenda da Igreja components: chamber (composition) and megaliths (units). Image taken from Montemorbase 3D model.

We plan to make the ontology available in OWL format so that we can rely on community reuse, refinement and extensions (<https://github.com/IvoSantos/MegalithismCIDOC>).

Following [1], we intend to develop information extraction (IE) mechanisms for this type of specialized textual corpora. For advancing in that direction, in a previous work [10], we presented the corpus on Portuguese Megalithism. Such domain specialized corpus will be manually annotated for the development of IE tools.



Fig. 3. Almendres cromlech, Évora, Portugal. Adapted from [2]. Photo by R. de Balbín

Knowledge organization and representation is an important step in order to make it possible to preserve the context of the megalithic monuments in its various facets: intrinsic context (archaeological), archaeological interventions and intervenients. In other words, the use of *Semantic Web* premises allow the implementation of an archaeological information structure in which all data are related in a known way, searchable and reusable, without exception. Simultaneously, by combining semantic capability and 3D modeling, this implementation creates the basis for further investigations. We plan to develop this interdependence between 3D modeling and monument information in future works.

The context in Archaeology is so important that it can determine the meaning and (archaeological) value of monuments and artefacts. However, the databases used in the discipline, as well as the academic projects and works themselves, usually do not include all the existing technological capabilities to safeguard this same context.

As archaeological practice incessantly seeks to complement the record with more and more digital techniques, archaeological information systems must follow this trend, including these digital data and safeguarding its context. The importance of context validates the demonstrated need for clarity, which only the principles of *Web Semantics* can grant to archaeological information. If context is everything for Archaeology and, technologically, the best way to describe a context is through semantically rich attributes, then, for this discipline, and in accordance with good management and data sharing practices currently in force, the use of computer application that values semantics, becomes essential.

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