

A DIGITAL ARCHIVE FOR THE AMULETS OF KERMA CULTURE: A PRELIMINARY STUDY

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Introduction

This paper deals with the amulets of the Kerma culture (2500-1400 BC), a largely unpublished collection brought to light at the site of Kerma in Upper Nubia, Sudan, during the archaeological investigations conducted by the Harvard-Boston Expedition under the direction of G.A. Reisner between 1913 and 1916 (Reisner 1923a-b). After his excavations, Reisner considered the site of Kerma to be a Middle Kingdom Egyptian trading station, somehow related to the forts built at that time in Lower Nubia (Reisner 1923b, 535-559). Investigations conducted in recent years have demonstrated that Kerma was the capital city of the powerful Nubian state named Kush in the Egyptian texts, which had a complete urban structure (Bonnet 2014; Bonnet, Valbelle 2014).

The study of these amulets, currently held in the Museum of Fine Arts (MFA) of Boston and in the National Museum of Sudan (NMS) of Khartoum will be the subject of a forthcoming monograph published by Harvard Egyptological Series (in agreement with the MFA of Boston) and granted by the Shelby White and Leon Levy Program for Archaeological Publications¹. The volume will be a comprehensive publication of the amulets of the Kerma culture excavated by Reisner in the last century, and as these have never published, it will provide the first insights into their production, development and significance. A total number of 1.767 Kerma amulets (1.746 collected by Reisner, that are now in Boston and in Khartoum, and 21 by Ch. Bonnet which are currently held in the Musée d'Art et d'histoire of Geneva) have been studied, and a great variety of amulets were identified. Full documentation of these finds currently stored in the MFA of Boston and in the NMS of Khartoum was accomplished during this research (Fig. 1). The study is aimed at elaborating a first typology and distribution analysis of the amulets in the Kerma culture, as the available publications are largely incomplete. Not all the amulets excavated by Reisner were included in his report "*Excavations at Kerma*" published in 1923. Reisner did not indicate what kind of amulets were found in each tomb, and he did not even specify their number. Moreover, photographic documentation was also very poor, as only two plates were devoted to this class of materials, therefore making it very difficult to get a clear idea of some types of amulets (Reisner 1923a, 89-133).

The Kerma culture did not have a written language so is difficult to understand the exact meaning of these amulets. We can only offer a hypothesis on their significance, via comparison with iconographies used in other artistic manifestations of the Kerma culture, and with Egyptian symbols that in some cases seem to have inspired some types of Kerma amulets. Therefore, any attempt at writing the history of the Kingdom of Kush can only rely on archaeological data (Bonnet 1990, 89). The study of the Kerma amulets can help us to obtain important information on the symbols and animals that were believed to have held a protective power. Because these objects are closely associated with religious beliefs, they can help us to understand some aspects of the Kerma religion.

ARCHIVAL DOCUMENTATION AND DATA

An important objective of *The amulets of the Kerma Culture* project is the digitization of these finds. In order to manage the whole *corpus* of the studied amulets, a relational database has been produced using *Microsoft Access*. Through this application it has been possible to virtually unify all the Kerma amulets, which are currently held in six different museums, for the first time.

Moreover, the emergence of online archives has facilitated greater access to new information, which can be disseminated much faster and in a greater quantity than in the past (Lock 2003, 219-252). The most significant contributions of the use of computer science allow us to manage a huge quantity of data and information for a more detailed diachronic and synchronic analysis of cultural and environmental processes (Forte 2003, 95-108).

In this research project digital archival methodology can be used as a tool for the reassessment, and facilitating greater access to Reisner's records. The Reisner Kerma excavation archive is housed at the MFA of Boston, and, as in the case with the majority of historical archives, it was previously only accessible in its physical form. Researchers have also had to rely on Reisner's publication of the site, which is massive, yet

¹ <https://whitelevy.fas.harvard.edu>.

condensed, and has effectively no indexing nor concordance with current museum holdings (Minor 2018, 253-254). Kerma objects from Reisner's excavations, as in the case of the amulets, are dispersed throughout various museum collections including in Khartoum, the Boston MFA, the British Museum, and the Harvard Peabody Museum. Due to the previous lack of a comprehensive concordance between the field numbers used by Reisner in his publication and the museum accession numbers, some Kerma objects have lost their precise archaeological context. Yet the key to associating the finds with the archival documents and images is Reisner's field number, which feature a prefix of year and month, followed by a running sequential number (e.g. 13-12-240). Reisner's multiple recording systems are thorough and can be cross-referenced. Available archival resources include card entries for each tomb with sketched plans and a list of finds, object registers with sketches and detailed object information, and handwritten diaries that provide a narrative overview. There are over 2,000 field photos in the Kerma archive, including images of objects in situ taken during the various stages of excavation, that can be used to reconstruct contextual information (Minor 2018, 253-254).

For the purposes of this research project, a relational database has been designed that has linked the Kerma amulets housed in the MFA of Boston, the NMS of Khartoum, the Musée d'art et d'histoire of Geneva (MAH) and the Harvard Peabody Museum. The database also collects the amulets found at Sai and Mirgissa kept in the Institut de Papyrologie et d'Égyptologie of Lille and those found at the sites of Lower Nubia currently held in the University of Uppsala and in the Oriental Institute of Chicago. A relational database is a set of formally described tables from which data can be accessed or reassembled in many different ways without the need for any reorganization. The main advantages of relational databases are that they enable users to easily categorize and store data that can later be queried and filtered to extract specific information for reports. The term relation is used in the mathematical sense of set theory, as in the relationship between groups of sets.

In *The amulets of the Kerma culture* database, data was organized into three different tables according to a relationship structure. The first table describes the contexts, the second the necklaces and circlets (Fig. 2), of which the amulets are often components, while the third lists all the amulets (Fig. 3). Each table contains further data categories organized into columns, also called attributes. These attributes describe the features of the finds and the archaeological contexts where the amulets were discovered. The table of amulets includes thirteen attributes and the table of necklaces eight. For the context table, there are thirteen attributes concerning the discovery site (such as the sector and the context type) and the data relating to the mission (such as date, site director and bibliography). Each table has a unique primary key which identifies the information. In our database the primary key is the *accession number* through which it is possible to show the relationship between the three tables. Therefore, two relationships were created: one called "one to many" and another called "one to one". The "one to many" relationship defines that between the table of necklaces and of the amulets, which means that each record in the table of necklaces corresponds to several of the records in the table of amulets. The "one to one" relationship means that each record in the table of necklaces corresponds to a single record in the table of contexts.

The three related tables provide information on the typologies and distribution patterns of these objects, with the aim of understanding any diachronic and synchronic differences in the distribution of the finds and to therefore detect any intra- and inter-site variations. Through the creation of queries, it was possible to interrogate our database by cross-referencing the data from the various tables. Having this resource greatly facilitated the archival research necessary for analyzing the frequency with which the different types of amulets appeared across the various periods of the Kerma culture. In addition, the distribution of these finds across the different sites in this study was analyzed. This resource confirmed the hypothesis that there are differences between the types of amulets found at the site of Kerma and those from the other sites. Exemplary are the schematic *amulet-bead* (Figs. 4-5) that appear largely absent from the tombs of the Kerma culture located in Lower Nubia and which were also unknown in Egypt (D'Itria 2018, 66-68).

DATA PUBLICATION

The value of the database lies in its ability to collect a variety of published and unpublished data from different sources. In the codification process, current knowledge of this corpus has been formalized into a conceptual structure capable of reflecting a level of inquiry relevant to the project's research goals. Thus, the dataset adheres to the same structure. According to this structure and the archaeological, temporal and spatial data, it has been possible to extract information through diachronic and synchronic analysis. However, such a structure unfortunately shows its limitations when new kinds of data, especially that of an interdisciplinary nature, have to be combined together for more complex analysis. For example, in our case, the data gained

from chemical analysis or other data formats such as images can illustrate these potential pitfalls. The tables which have their primary keys linked through established relationships define a very close system, which is almost impossible to expand upon except through a change to the whole structure because of the inherent top-down approach of the database. Such an approach involves starting from the general and moving to the specific, which entails an *a priori* elaboration of a conceptual schema based on the knowledge of data and their relationship that users need to store. This means that the end-users of the database have to have a detailed understanding of the tables, attributes and relationships. Only through an awareness of the relationships and attributes is it possible to create *ad hoc* queries obtaining the expected results.

This approach presents two main problems: the formalization of knowledge and the data sharing. Information in a database can be described in different ways according to what is deemed important. However, the terminology used does not conform to standard vocabularies nor are thesauri applied. The absence of a standard does not allow the integration and sharing of data, and different formats produced by other software programs are clear an impediment to any interoperability. Furthermore, the top-down approach is in opposition to the philosophy of the Web which favors Open Access and the continuous expansion of the network of data.

All these problems raised by our archaeological database are anachronistic partly because they have already been touched in other disciplines and partly because they appear to be opposed to the principles of long-term preservation, reuse, interpretation and sharing of knowledge. Yet in archaeology, different recording methodologies and a discontinuous use of standards exist. However, the increasing number of projects aimed at the digitalization of archaeological archives can guide us towards a different approach, which supports the accessibility of an enormous amount of archaeological information for both researchers and the wider public.

Data publication entails the free availability, sharing, implementation, use and reuse of data among several users or researchers. Open data is the term that refers to the full publication of data. Access to data enables a pattern of reuse and knowledge creation that was previously impossible (Costa *et alii* 2014, 450). The sharing of open data via the Web is not a new practice; for the publication and the creation of our digital and open archive, we were inspired by existing projects, such as *Europeana*, a digital library and aggregator of different kinds of data (documents, images, videos, 3Ds) concerning European cultural heritage. Here, the data providers are European cultural institutions who decide to publish their data, thus making them accessible and useable. Data are published according to the standard *Europeana* Data Model metadata which defines how data are processed and presented.

Established services also exist, such as the UK-based Archaeological Data Service (ADS)², an open-access digital repository that collects data sets within the area broadly defined as Archaeology and the Historic Environment, including that which can be classed as pertaining to Ancient History and the Classics; and Open Context, a free open-access resource for the publication of primary field research from archaeology and related disciplines on the Web³. Both the ADS and Open Context repositories are based on standard metadata for describing data and they use Linked Open Data technology.

FROM DATABASE TO LINKED OPEN DATA (LOD)

Data publication means that data are shared on the Semantic Web, the common virtual reality where all people can access and interact with data. According to the definition of W3C: "The Semantic Web is the Web of data, of dates and titles and part numbers and chemical properties and any other data one might conceive of. The collection of Semantic Web technologies (RDF, OWL, SKOS, SPARQL, etc.) provides an environment where the application can query that data, draw inferences using vocabularies, etc.

However, to make the Web of Data a reality, it is important to have the huge amount of data on the Web available in a standard format, reachable and manageable by Semantic Web tools. Furthermore, not only does the Semantic Web need access to data, but *relationships among data* should be made available, too, to create a *Web of Data* (as opposed to a sheer collection of datasets). This collection of interrelated datasets on the Web can also be referred to as *Linked Data*" (<https://www.w3.org/standards/semanticweb/data>).

Linked Data refers to a technology where data are published on the Web in such a way that it is machine-readable, its meaning is explicitly defined, linked to other external data sets and can in turn be linked to from external data sets (Bizer *et alii* 2009, 2). The term Linked Data is used to describe a method of

² <https://archaeologydataservice.ac.uk>.

³ <https://opencontext.org>.

exposing, sharing and connecting data via URIs on the Web (<http://www.w3.org/designIssues/LinkedData.html>).

Berners-Lee (2006) outlined a set of “rules” for publishing data on the Web in a way that all published data become part of a single global data space:

1. Use Uniform Resource Identifiers (URIs) as names for things.
2. Use HTTP URIs so that people can look up those names.
3. When someone looks up a URI, provide useful information, using the standards (RDF, SPARQL).
4. Include links to other URIs, so that they can discover more things (Bizer *et alii* 2009, 2).

According to the definition of LOD and the set of rules, data are identified with URIs, which are used to represent information about a certain domain. This works as a means of identifying any entity that exists in the Web. With URIs, all data become Resources that could be represented on the Web. It means that it could be represented as an HTML page, a printable PDF document, and so on. Data identified with URIs use the HTTP:// scheme, a protocol that provides a simple universal mechanism for retrieving resources. URIs and HTTPs are associated with the Resource Description Framework (RDF) which provides a graph-based data model. The RDF model encodes data in the form of subject, predicate and object triples with which to structure and link data that describe things in the world. Each element of the triple is an URI, and while the subject and object identify a resource, the predicate specifies how the subject and object are related. Representing data in this way allows one to interconnect heterogeneous resources and navigate the Semantic Web through links. Furthermore, LOD is provided by vocabularies used to describe entities in the world and their relationships. Metadata are used to assess the quality of published data and to allow both humans and machines to identify semantic values. Thus, LOD represents an early but fundamental shift towards a digital resource culture.

The use of LOD in archaeology requires a change of perspective and the acquisition of new skills. From an archaeological point of view, it is a new opportunity, especially if we consider the growing amount of data, of various type, format, structure and scale.

The goal of our project is to integrate the interpretative work of archaeological science with the most effective techniques of data management and analysis to contribute to the wider scientific community.

All of this begs the question: how can Linked Open Data be managed to publish our archive?

The workflow process (Fig. 6) establishes the following steps:

1. Use a standard for the description of data.
 - a. Identify the metadata and standard terminologies such as vocabularies and thesauri (AAT, Geonames...).
 - b. Map the relational database schema to the concepts represented by the metadata and use vocabularies and thesauri.
 - c. Use URIs.
2. Export data into a repository in an open format to ensure their interoperability.

According to this process, each record on the database becomes a resource described with Metadata attributes and related to another resource with Metadata properties (Fig. 7). In the RDF model, a single amulet, entered into the database with an accession number, is the subject of the triple and is provided by a URI. This resource is linked through an URI to a necklace, which is also entered into the database with a number, and this represents the object of the triple (Fig. 8).

In this way, a cloud of resources can be created, encoding the meaning in both a human-readable way and a machine-understandable form.

The publication and sharing of open data via the Web is not a new practice. For this reason, the publication and the creation of the digital and open archive for this project has been inspired by existing projects, such as *Europeana*. Otherwise, established services exist, such as the Archaeological Data Service (ADS)⁴, tDAR and Open Context. Both ADS and tDAR mainly aim to digitize and preserve data, while Open Context, which is also based on the concept of preservation, highlights the issues of data sharing and openly accessible publications.

The challenges of preserving archaeological data, usually in a myriad of formats, has long been considered a problem because of the different standards used to record and manage information. To solve the problem, standard metadata, vocabularies, thesauri and ontologies have been adopted. ADS is the best known digital repository in the UK that collects data sets within the area broadly defined as Archaeology and

⁴ <https://archaeologydataservice.ac.uk>.

the Historic Environment, including Ancient History and Classical Archaeology. There are two the main tasks: deposit data for the digitization process and long-term preservation; review the accessibility of the data and the potential reuse of said data in future projects. ADS provides good practice guidelines for depositors to identify the available resources quickly. A faceted classification and geospatial browser for the ADS database, with the main facets for browsing falling into the categories of “What,” “Where,” “When,” and “Media”, allow users to search information. All facets were populated using existing thesauri that were marked up into XML and then integrated using SKOS.

The Digital Archaeological Record (tDAR)⁵ is an international digital repository in the US responsible for the digital records of archaeological investigations with a special focus on American archaeology. tDAR's use, development and maintenance are governed by Digital Antiquity, a multi-institutional organization with the aim of ensuring the long-term financial, technical and social sustainability of tDAR. The two major goals of Digital Antiquity are to provide a preservation repository for archaeological reports and data and to provide sophisticated access to those. Data are grouped into projects and collections. Guidelines on Good Practice⁶ have been produced as the result of a two-year collaborative project between the ADS and Digital Antiquity. A commonly used format for project-level metadata is Dublin Core⁷. The standard consists of fifteen core elements (eighteen in the qualified version) that can provide a detailed overview of the project as a whole. Within tDAR, the basic Dublin Core metadata schema has been extended to include archaeology-specific fields as well as to include fields from the Metadata Object Description Schema (MODS⁸). Metadata can be further completed in a controlled way through the use of specific, standardized word lists and thesauri, including but not limited to the Forum on Information Standards in Heritage (FISH) Thesauri vocabularies⁹ and the Getty Thesaurus¹⁰.

Open Context is a free, open-access resource for the publication of primary field research from archaeology and related disciplines on the Web¹¹. The main aim of Open Context is to publish and explore data, that is why this feature is much more developed here than in the ADS and tDAR, as it uses the 100% open source technologies. The California Digital Library of the University of California provides data archiving and preservation services. Open Context has a highly abstracted and generalized global schema for representing data. This general approach takes its inspiration from the data structure developed by the OCHRE project (originally called “ArchaeoML”). Over the years, Open Context has evolved from ArchaeoML and moved towards Linked Open Data approaches to data organization¹². Thus, it emphasizes RDF and Linked Open Data to relate the data it publishes with the data curated by external sources. Open Context uses a variety of ontologies and controlled vocabularies described in OWL and SKOS¹³. The interface is well defined because it has a powerful Application Program Interface (API) that enables users to search, browse and visualize data, but also to analyze data and link to Open Context records. This is all built on a model of faceted search / faceted browsing¹⁴.

In light of these considerations, for the moment we believe that the Open Context services responds to the project's requirements concerning the openness of data also when considering its policy licencing and copyright, thus allowing us to publish structured data and digital-born data on the web using only open-source technologies. Thus, we think that it will give greater value to our archive.

CONCLUSION

The digitalization of the whole corpus of the amulets of the Kerma culture is the most effective way of ensuring that these data can be archived and preserved to provide further knowledge on this culture. The initial and main aim of *The Amulets of the Kerma culture* project was to catalogue all of the amulets excavated by G. Reisner, which had remained in the storerooms of various museums for over a century.

⁵ <https://www.tdar.org/about>.

⁶ https://guides.archaeologydataservice.ac.uk/g2gp/CreateData_1-2#ref-CreateData_1-2-8.

⁷ <https://www.dublincore.org>.

⁸ <http://www.loc.gov/standards/mods>.

⁹ <http://www.heritage-standards.org.uk>.

¹⁰ <https://www.getty.edu/research/tools/vocabularies/aat>.

¹¹ <https://opencontext.org>.

¹² <https://opencontext.org/about/technology>.

¹³ <https://github.com/ekansa/oc-ontologies>.

¹⁴ https://opencontext.org/about/services#tab_intro.

Another important goal of the digitalization of these finds was to virtually unify all the amulets of the Kerma culture that are still scattered through different collections. The relational database realized appears to be a complete collection of all of the available data on the Kerma amulets, including all their intrinsic (such as dimensions, materials, state of preservation) and extrinsic information (discovery site, director of the mission, present location). This research focused primarily on the finds kept in the MFA of Boston and the NMS of Khartoum. This was then expanded to include the amulets excavated by the Swiss Mission, those from the island of Saï and those found in Lower Nubian sites, all incorporated in this database. These additions were considered to be of crucial importance for this research project in order to get a full and accurate overview of the distribution of the amulets throughout the different sites of the Kerma culture.

We believe it is important that the Semantic Web is not seen as intended to replace or substitute conventional data archiving. The creation of a personal database or the use of a spreadsheet sometimes appears the fastest way to record information, especially when one works in difficult situations without an internet connection. Nevertheless, we know that an enormous amount of information still remains inaccessible to the general public and researchers. The most striking example is the Sudanese National Museum of Khartoum. The archaeological material in the museum collection is only published in papers by researchers there; the catalogue of the NMS is only available in paper format yet it does not include all of the material kept in the museum; most of the objects are only briefly recorded in books or in some cases even forgotten in the storage rooms. Therefore, publication becomes crucial for the long-term preservation of the data.

In *The Amulets of the Kerma culture* project, a data management plan will be fundamental to data sharing, leading to greater collaboration with the wider research community and further advances in research. We are actually producing our publications much more efficiently than we ever have before and are helping to ensure a future for the data in term of sustainability.

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Fig. 1 - *Faïence* beads and *amulet-beads* collected by G.A. Reisner in the site of Kerma currently held in the storerooms of the National Museum of Sudan, Khartoum



Fig. 2 - String of *faïence* beads and *amulet-beads* representing baboons (6), ladders (4), Tawret (16), and one hand, found in the Eastern cemetery of Kerma, tomb K 311 (NMS 1004)



Fig. 3 - Amulet representing a hippopotamus in *faïence*, found in the site of Saras (NMS 22596)



Fig. 4 - Amulet-bead which shows a baboon, found in the Eastern cemetery of Kerma, tomb K 1604 (NMS 1040)



Fig. 5 - Amulet-bead representing Tawret, found in the Eastern cemetery of Kerma, tomb K 1600



Fig. 6 - The workflow process of *The amulets of the Kerma culture* project

ID	ACCESSION NUMBER	FIELD NUMBER	INDICAZIONI SUL SOGGETTO	DESCRIZIONE	FASE CRONOLOGICA	MATERIALE	LUNG
193	1004	13-12-854	tawret	tawret raffigurata di profilo, schematizzata	KERMA CLASSICO	faience blu	
194	1004	13-12-854	babuino	babuino raffigurato di profilo, schematizzato	KERMA CLASSICO	faience blu	

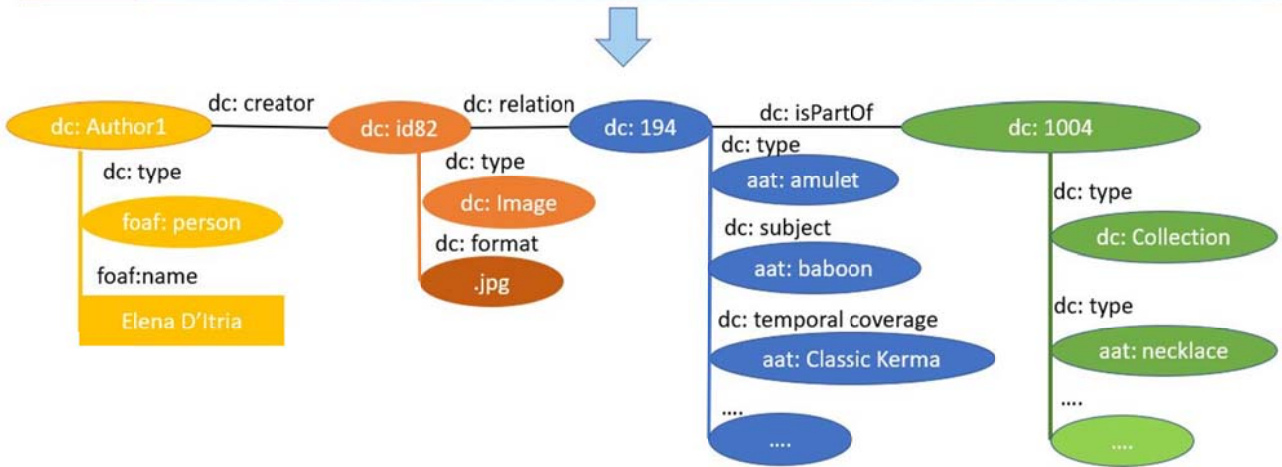


Fig. 7 - The mapping with Metadata Standard

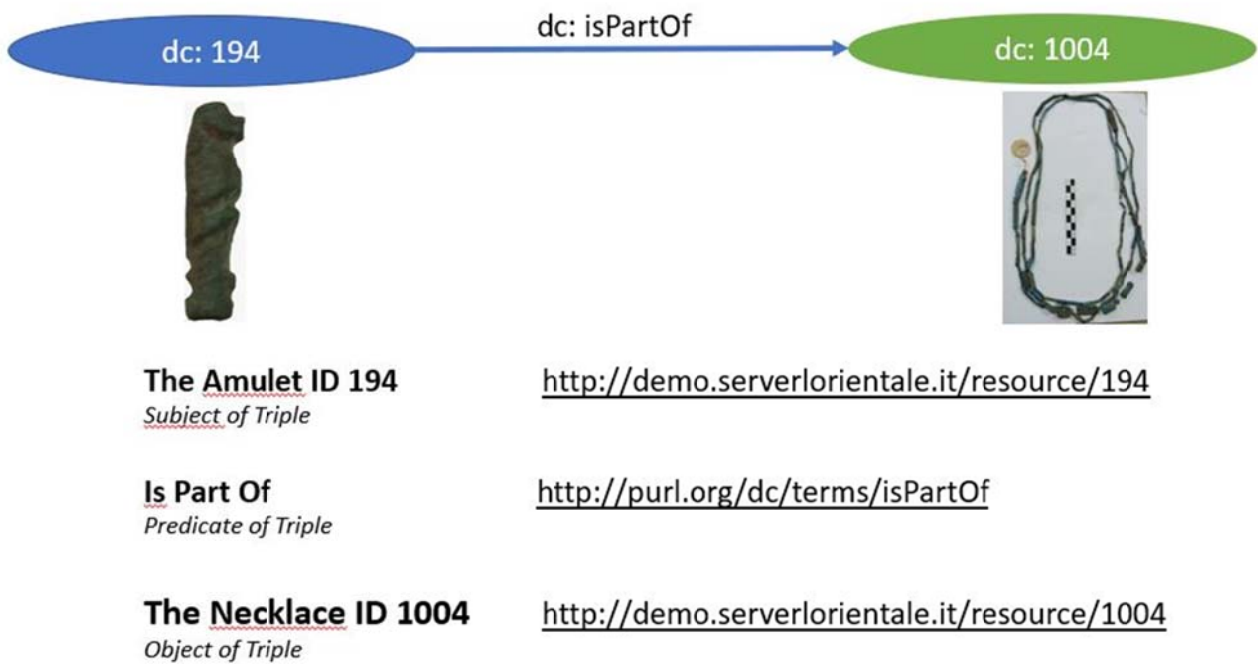


Fig. 8 - The records of the database become resources on the web