

THE CYLINDER SEAL AS A CHALLENGE FOR QUANTITATIVE INVESTIGATION, ELECTRONIC CATALOGUING AND DIGITAL VISUALIZATION

1. INTRODUCTION

Cylinder seals and their iconographies historically have been the favoured subject for the application of quantitative methods in the art history of Western Asia. In particular the compositions of motifs carved on the surfaces of cylinder seals have always been very tempting for quantitative analyses. This is perhaps due both to the long and widespread tradition in ancient production and use of this class of artefacts, and to the well-documented geographic and historical developments of glyptic iconography and styles throughout pre-classical Western Asia. Such a rich source of raw data and potential secondary information stimulates various types of experimental approaches, and favours the analyses and assessments of relevant experiences. Furthermore, if one considers how much information related to cylinder seals is dispersed, it is evident that quantitative methods can play an important role and are definitely needed. I refer in particular to those methods which permit the arrangement and organisation of available material, and enable the undertaking of large-scale investigations.

Nevertheless, the study of seals using quantitative methods can be challenging. It presents various levels of complexity and stimulation depending on the chronological and geographical boundaries of the chosen *corpus*, the number of seals under consideration, and the ultimate aims of the investigation. This challenge is particularly intriguing, since the study of cylinder seals gives a privileged perspective on Near Eastern pre-classical historical societies: indeed, it allows us to obtain a potentially vast amount of information on the developments of these societies with specific regard to their administrations, political systems, craftsmanship, and artistic cultures.

2. CYLINDER SEALS

Experimental investigations into any categories of artefacts require, in most cases, the use of primary data which can be observed and recorded only from original specimens. As a result, direct contact with the physical objects is necessary. General or specific catalogues, excavation reports and similar, be they printed or digital, can only present a fairly limited amount of data. Moreover, such data are recorded using procedures which inevitably differ according to the year in which the catalogue was drafted and the education, interests, and training of the scholars and personnel preparing the catalogue.



Fig. 1 – Cylinder seals and their modern impressions, Musées royaux d’Art et d’Histoire, Bruxelles, O.00080, above, and IR.0018, below.

For reasons related to persistent habits generated in the nascent period and the early developments of Western Asiatic glyptic and philological studies, the catalogues of cylinder seals and cuneiform documents have been often parsimonious with basic information. For too long the common way of thinking about and discussing cylinder seals was strictly bound to the visualisation and investigation of glyptic iconographies, with little or no attention paid to the other physical features of such artefacts.

Of the latter, in most cases only the dimensions and the material of the cylinders are reported. Then, the motifs and iconographies carved on the cylindrical surface are shown in the form of their positive impressions on clay (Fig. 1; an interesting overview of the earliest graphic reproduction of seals in modern Europe has been developed in ΕΡΡΗΙΜΕΡ 2018). These take the form of modern – carefully executed – complete impressions of the seals in clay or a similar material, and they are traditionally considered the most important and explicit sources of information in the publication of glyptic artefacts. These are indeed rich and clear representations of the seals’ iconographies, but do not represent the artefacts themselves, nor do they truly demonstrate their common ancient use.

The cylinder seal is a complex product which contains a variety of values and cultural features. During the long period in which a seal was used, it was

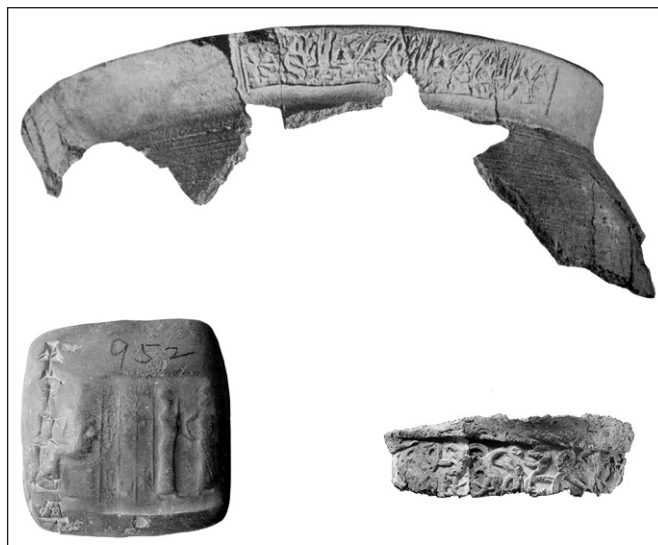


Fig. 2 – Ancient seal impressions: on a Syrian Jar from Ebla (TM.89.G.383/1, MAZZONI 1992, n. A 41), above; on an Ur III administrative tablet of the Yale Babylonian Collection (YBC 952), below on the left; on a clay cork of the Musées royaux d'Art et d'Histoire, Bruxelles (O.03929), below on the right.

rolled on wet soft clay in order to seal rooms, containers, or documents (especially those of a commercial and administrative nature). They were also used to decorate or mark the ownership or manufacturer of vessels (Fig. 2). These are the uses of seals most commonly considered by research, but over the course of almost three millennia the cylinder seals were often also used as personal ornaments or amulets, dedicated in cultural places, and there are good indications that – at least in some periods – they were also conceived as representations and extensions of their owners or users (CASSIN 1960; COLLON 2001; WINTER 2001; DI LUDOVICO 2005, 57-60). This means that in daily life, seals were probably observed and perceived through their material nature much more than through their iconography. Since they were worn in direct contact with the body, their weight, colour, thermal capacity, and other features of these objects were most probably experienced much more than their bald iconographies reproduced on a plain surface. The iconographies themselves were conceived and observed most often in their negative form, that is the form in which they were carved on the seal, and also in their cyclical nature, since they exist on a cylindrical surface.

For these reasons, the modern seal impressions made in laboratories which give a plain, complete and positive version of the whole iconographic apparatus carved on the cylinder are completely abstract projections of these

artefacts. Though they are useful for the investigation and comparison of visual language and related features, they do not represent the seals as concrete objects. Nor do they inform us of the issues that most closely concern these objects: their production, and the way they were handled. Similarly, modern impressions are not representative of original ancient sealing procedures, which also varied over time and across geographic areas. Evidence suggests that ancient seal impressions were made according to other logics, related to specific meanings and intentions (DI LUDOVICO 2010, 2013).

Ancient seal impressions have not yet been consistently investigated, and this is partly because many of them appear on cuneiform documents, which in the traditional research approach fall exclusively within the field of philologists and epigraphists, rather than in that of art historians or archaeologists.

3. ELECTRONIC CATALOGUING: FROM THE *RÉPERTOIRE* TO INSCRIPTIFACT AND CDLI

The earliest proposals concerning the systematic recording of data about ancient Western Asiatic artefacts for research and publications were focused on various classes of materials, among which cylinder seals. They were based on digital approaches and quantitative logic, and began to appear in scientific literature in the 1950s. Later developments of such approaches and further comparable proposals were – in most cases – more and more centred around cylinder seals, and the optimal ways to outline and record their basic features. However, these were primarily iconographic, and thus no specific critical views were yet expressed in relation to the need for representing and investigating glyptic products as complex cultural objects.

The use of quantitative methods in the archaeology and art history of Western Asia, and the relevant methodological reflections, began with the proposals and critical observations of Jean-Claude Gardin and his colleagues of the Institut Français d'Archéologie at Beirut. Gardin's fundamental idea was to develop automatic systems based on quantitative methods which could support the investigation, filing, and classification of diverse types of archaeological artefacts (GARDIN 1958). To undertake this ambitious challenge, it was first necessary to devise and tune a universal code, in order to describe ancient artefacts unambiguously and fairly precisely. The theoretical tools which were adopted, and the logical steps that had to be followed, were necessarily based on the experience of the "analyse logiciste". The first result of such efforts was a digital and automatised model which involved the treatment of pre-classical Western Asiatic visual languages, and primarily concerned the iconography of cylinder seals (GARDIN 1967).

Gardin's approach aimed at a formalised description of the iconography of seals, paying attention to both the components which could be outlined

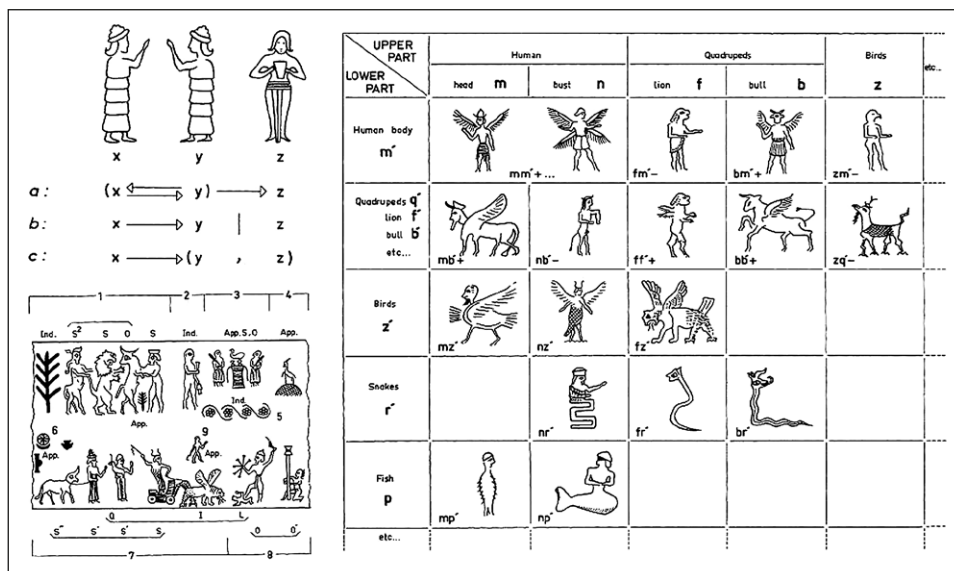


Fig. 3 – Some encoding proposals by J.-Cl. Gardin.

and the syntax of the composition (Fig. 3). The concrete outcome was quite satisfactory, especially if one considers that it was a pioneering experience, but the peculiar cylindrical syntax of the artefacts and many physical features were not really taken into account. The algorithms and the systems which had been proposed, and thus experimented, generated wider and more ambitious experiences. The proper synthesis of this was the *Répertoire Analytique des Cylindres Orientaux* (DIGARD 1975), which was a collection of systematically encoded information on cylinder seals that had been published in journals or excavation reports (and as such was usually absent in catalogues explicitly dedicated to cylinder seals). Besides an in-depth explanation of the logics, functioning, and aims of the work, the *Répertoire* also included a huge collection of entries which formed a first – and still today unique in the field – complex catalogue allowing for cross-referencing.

This includes the homogeneous representation and description of artefacts previously published unevenly, in different periods, and by very different authors. Furthermore, those seals have the most diverse geographic and cultural origins, which makes the encoding work of their iconographies especially complicated. For these reasons, the experience of the *Répertoire* was definitely suitable for both carrying out a serious test bench, and producing an instrument based on the logicist approach which could be used immediately and profitably by scholars. It included tools for the automated search and

comparison across the iconography of seals, and also for their traditional manual investigation. The *Répertoire* was certainly welcomed in the scientific world, but, as the team of CNRS could well imagine since its publication, there were few chances for a true follow-up of that initiative. In any case it became a milestone for similar future initiatives, not all of which entirely successful. In subsequent years, further proposals for automated cataloguing systems were prepared, but they did not result in concrete and usable tools (KELLY-BUCCELLATI, ELSTER 1973; KELLY-BUCCELLATI 1977; 1979-1980).

Only in much more recent times, efforts toward the production of a large (and possibly open) archive of cylinder seals were once again fostered in different ways and with different strategies.

The project InscriptiFact (<http://inscriptifact.com>) is an online open database developed since 2003 within the West Semitic Research Project (WSRP – University of Southern California), and is mainly oriented to the documentation and preservation of ancient texts from Western Asia (HUNT, LUNDBERG, ZUCKERMAN 2005; 2014). The WSRP was born of a need felt to be extremely urgent in times in which war events, and many uncontrolled phenomena triggered by them, seriously endangered the heritage of Western Asiatic countries. In the frame of InscriptiFact the cylinder seals, considered as possible inscription bearers, began to be recorded and represented as digital rollouts of their surface. This means that from the beginning of the third millennium *era vulgaris* the cataloguing systems of cylinder seals and their iconography began to be related not just to the issues and questions of the encoding strategies, but also to the theme of representing them visually in a satisfactory way. This represents a further step towards the consistent recording of features concerning the materiality of seals.

Comparable problems and ambitions have also been faced within the project known as the Cuneiform Digital Library Initiative (CDLI, still active: <https://cdli.ucla.edu>; TSOPAROPOULOU 2014). It was first created as a large online database for cuneiform documents, but there are more recent attempts to enlarge it to include cylinder seals. The most interesting and recent of such attempts falls within the project SIANE (Seals and their Impressions in the Ancient Near East, see DAHL *et al.* 2018), which lasted one year and involved a number of specialists in many fields who sought to develop a suitable standard for a catalogue of digital unwrapping of cylinder seals. The system adopted was based on mixed techniques (structured light scan, digital microscopic images, etc.) and aims to integrate the CDLI catalogue with accurate documentation.

4. THE VISUALISATION EXPERIMENTS

The experiments for optimized visualisation of cylinder seals began partly as a collateral solution for secondary problems which emerged in projects

dealing with digital archives. As seen above, the nature of this class of artefacts is such that even the mere publication and visualisation of them involve a number of scientific issues. The first important experiment for a new way to reproduce cylinder seals in publication, and one of the most recent ones have been just mentioned, but the relevant debate and approaches were various and multiform, and have developed along interesting paths in the last two decades.

Important efforts in this direction were actually also already being produced in the early years of the new millennium, probably also because of the easier (from both technical and economic points of view) access to new digital technologies able to produce high-level physical documentation of the artefacts. Researchers of the CNR at Pisa and the C2RMF in Paris carried out an important experiment with X-Ray based techniques and photogrammetry on a seal in the collection at the Louvre (PITZALIS *et al.* 2008). The final result of their research had a very high level of detail and diagnostics of the state of preservation of the monument (Fig. 4). Unfortunately, it is an overly expensive and time-consuming investigation procedure, and so not suitable for application on a large scale.

A little later, an interesting and quite economic experiment was carried out by Paul J. Boon and Martine de Vries-Melein (BOON, DE VRIES-MELEIN 2009, 2012, 2013): with the techniques and logics of the “object movie”, they could obtain reproductions of the surface of cylinder seals at digital high resolution, albeit missing the cylinder’s bases and the outer ends of the axial perforation. This resulted in a web publication of rollouts of seals selected from the Dutch NINO collection, but the relevant project ended relatively soon. Similar to this procedure was the one proposed by a research team of Heidelberg, which made a device specifically to facilitate the photographic reproduction of the surfaces of cylinder seals. A test on fourteen seals was carried out using the Structure-from-Motion photogrammetry, and it gave interesting results (REH, SEITZ, SPECK 2016).

All these initiatives did not reach the goal of a consistent in-depth recording, encoding, and publication of the cylindrical glyptic artefacts, but they documented their inner compositional syntax and the colour of the stone in an advanced and potentially fruitful way. In the first one it was even possible to show important traits of the physical structure of the cylinder’s material. In recent years further proposals have come from Klaus Wagensohnner, who cooperates with various research institutions looking for an optimized solution for the 3D reproduction of cylinder seals (WAGENSONNER 2014, 2015). In part he developed the experiences of the West Semitic Research Project further, in part he sought other methods. Once again his aim was to obtain digital rollouts of the cylinders which show the colour and the texture of the seal at a detailed enough level. For the latter goal the recording of High Dimension Range (HDR) photos proved to be very effective.

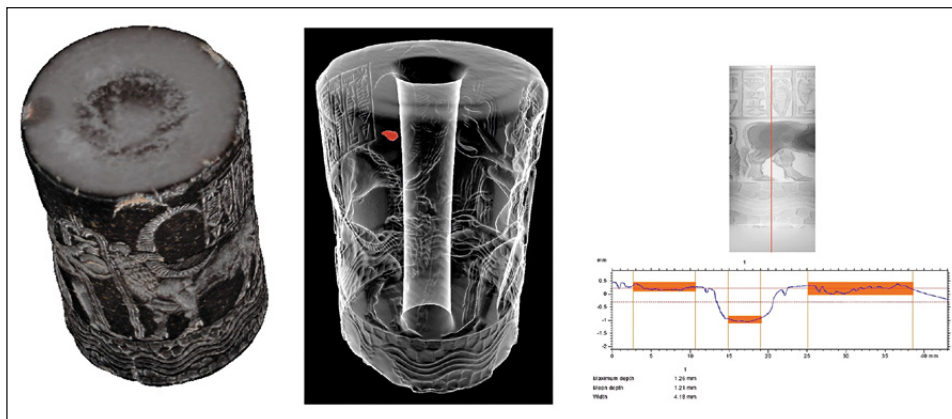


Fig. 4 – Composition of figs. 5, 3, and 4 of PITZALIS *et al.* 2008.

These experiments are still in progress and involve a dome camera, alongside other tools, which has been productively used before with clay tablets at Leuven (HAMEEUW, WILLEMS 2011) and which is being used in the project SIANE.

5. QUANTITATIVE STUDIES ON CYLINDER SEALS

The other remarkable perspective through which the cylinder seals have proved to be a primary field of investigation in ancient Western Asiatic studies, is the quantitative investigation of visual languages. Statistics and various types of mathematical algorithms were used to investigate the iconographies and the compositional arrangements represented in the cylinder seal carvings. Elena Rova and Sergio Camiz experimented the use of various types of statistical analyses on a huge early historical *corpus* of Mesopotamian specimens in the 1990s (ROVA 1994, 1995; CAMIZ, ROVA 2003; CAMIZ, ROVA, TULLI 1998, 2003). Subsequently, since 2004, Alessandro Di Ludovico has used different types of algorithms (among them, also some related to the category of the Artificial Neural Networks) on the smaller – but much more homogeneous – *corpus* of the late third millennium presentation scenes (DI LUDOVICO 2005, 2011, 2018; DI LUDOVICO, PIERI 2011; DI LUDOVICO, CAMIZ, PIERI 2013; DI LUDOVICO, CAMIZ 2014). The results were encouraging, and the stimulating comparisons with the experiences of Rova and Camiz have led him to look for new strategies and paths in the realm of statistical analyses. Such investigations are still in progress, with a refined encoding system and an enlarged *corpus*.

All of this research concerns itself with the peculiar way in which ancient peoples thought of the compositional field of the seals and their symbolic

value, and so designed the specific use of that field. For this reason, they would benefit enormously from publications in which the cylinders and their impressions would be described and graphically represented, with due care for their physical properties and materiality. An optimal procedure should allow the collection of detailed data on the iconographies carved on the cylinders in parallel to their proper three-dimensional digital reproduction.

6. PRODUCTIVE PROPOSALS

There are basic issues and problems which need to be faced while developing all types of experiences in visualisation, cataloguing, and quantitative investigation of ancient Western Asiatic cylinder seals. Cylinder seals are complex products which traditionally have been researched with a focus on their iconography, but the quantity and variety of information which they can bring to the attention of scholars is much greater. A critical examination based on concrete experiences, like those discussed here, can be the starting point for an integrated approach which could merge an optimal visual representation and the collection of concrete data on seals, and a dynamic quantitative investigation of them. New technologies are increasingly opening ways for possible large-scale approaches which can face the multiform challenges related to this class of artefacts in the current age, but this does not necessarily imply an ideal solution in the very near future. An essential issue which can be already addressed concerns the opportunity of sharing data beyond the models, and to be able to manage them and the development of the latter through free methods. In some of the experiments mentioned this attitude is already actual and effective, and it will hopefully continue to spread.

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ABSTRACT

In ancient Western Asiatic studies glyptic has been historically the preferred subject for quantitative experiments and investigations. In most cases this led to stimulating and complex challenges which deserve to be critically discussed and analysed in order to find a proper use in the field of recently developed technologies and models. Cylinder seals in particular compel the scholars to face the close connection between the development of an optimal representation of the artefacts in primary publications and the building of strategies for their quantitative investigation. A synthesis of past experiences and present issues is presented here.