SigNet: A Digital Platform for Hellenistic Sealings and Archives

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Abstract. The paper provides an overview of the SigNet Project with special attention to the implementation of a digital agenda fitting the dual purpose of promoting scientific research in the specialized disciplines of sigillography and numismatics and of bridging their gap with the broader field of cultural heritage. Focus is in particular on the role of interdisciplinary, open linked databases of big data and on the promotion of citizen science.

Keywords: Sealings · Numismatics · Archives · Hellenistic age · Iconography · Linked open data · Big data · 3D scan · Open source · Citizen science · Public engagement

1 Positioning Ancient History Research in the Digital Era: Big Data, Digital Cultural Heritage, and Citizen Science

SigNet is a project proposal for the study of Hellenistic seal impressions and coinage (*ca.* 330-30 BCE), currently under evaluation within the framework of a "Digging into Data" call for projects.[1] The project's aim is to develop digital tools for advancing research of the material as well as to make the material widely available for further study. Image recognition software, such as developed for numismatic analysis, will be used not only for the benefit of comparing hoards of sealings, but also for cross-referencing existing coin databases. Online resources, such as an umbrella website, blogs and open-access papers will facilitate the dissemination of the results of the research.

This collaborative project comprising of American, Dutch and French teams will be the first time that coins and sealings will be studied in conjunction rather than

[1] http://diggingintodata.org.

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isolation.[2] The international and interdisciplinary SigNet Project brings together scholars in related fields of expertise, and is established to address several general and more specific questions about the interrelationship between seals and sealings on the one hand, and seals and coinage on the other. These small-scale or miniature artifacts carry images of various kinds – from gods to symbols of religious and administrative importance – which have never been compared systematically. Digital tools will be created and employed as aids in collecting, collating and analyzing the large data-sets at our disposal. State-of-the-art software will facilitate the cross-referencing within and across the (thus far first and only) digital image repository of seal impressions from selected Hellenistic archives and coin collections complemented with metadata available for statistical analysis. Such a tool will offer the potential of exploring and interpolating data in order to address a wide variety of research questions within the Humanities and Social Sciences.

Building on software created for coins by the American Numismatic Society and combining the existing databases and digital files of different hoards of sealings and multiple coin collections, the SigNet Project will address research questions relevant to the Humanities and Social Sciences in transformative and novel ways. The Hellenistic world involved a larger network of connections than previous eras. Interpreting overlapping networks on the level of iconography and archival practices will be significantly enhanced by employing large-scale, qualitative as well as quantitative data analysis. Combining sources of different – though related – nature overcomes the divide existing between highly specialized fields of research. As coins tend to be marked with a deducible year-date in which they were minted, numismatic evidence provides a firm chronological basis and can thus enable a more accurate dating of comparable sealings. Standardizing the data-sets of different miniature artifacts into a single repository, taking into account the option of future adjustments, by calibrating and correlating the source material will doubtless have invaluable consequences for increasing the scientific accuracy of the analyses.

The immediate pay-off of the project is to assist students in various areas of history, classics and archaeology, as well as (junior and senior) colleagues in related fields of expertise, such as iconography, numismatics, glyptics and of course sigillography itself. The research teams consist of a combination of senior and junior researchers, allowing younger scholars to develop new skills and improve their existing talents. The Dutch team will furthermore invite a post-doctoral fellow for performing statistical analysis and thus increase her or his experience. The collaboration of experts in various disciplines is expected to lead to mutually inspiring new insights.

[2] The teams constituting SigNet are led by Dr. Marie-Françoise Boussac (Université Paris Ouest), Dr. Sharon C. Herbert (University of Michigan, Ann Arbor) and Dr. Wim M.H. Hupperetz (Allard Pierson Museum, Amsterdam). Partners include experts associated with the American Numismatic Society (ANS, New York), Archéologies et Sciences de l'Antiquité (ArScAn, Nanterre), Histoire et Sources des Mondes Antiques (HiSoMa, Lyon), Fondation Gandur pour l'Art (Geneva), and the Universities of Louvain and Turin.

However, there is more. The SigNet Team believes that the combination of the chosen evidence and methodology provides suitable premises for developing cutting-edge tools as well as for innovative and replicable strategies for big data enrichment, standardization and quantitative as well as qualitative analysis both in the Humanities and the Social Sciences. Moreover, SigNet will offer tools for bridging the gap between specialized scholarship and the broader field of cultural heritage. In the following sections we will first focus on the basic features of the research, including the digital tools which will be specifically developed for the project; then discuss the research environment in which SigNet will develop and with which it will integrate; and end with some observations about how we hope to encourage the interaction with larger society. In this respect we intend to make our research results available to all levels of society. We support the application of all available methods, including open-access policy and citizen engagement, for the exchange of ideas between specialists and citizens. We thus align ourselves with the compelling vision arguing for the importance of disseminating scientific research as widely and effectively as possible.

2 Digging into (Big) Data: Archeology and Iconography

2.1 The Evidence: Archives of Hellenistic Sealings

The research planned by the SigNet Project focusses on the Hellenistic World, the territories conquered by Alexander the Great and held under Greco-Macedonian political control from *ca.* 330 to 30 BCE (Fig. 1). These territories stretched from the Aegean to Afghanistan, were ruled by different forms of government, and were inhabited by multi-ethnic populations. Following Alexander the Great's campaigns from Macedon to India, a substantial change in administrative practices occurred across the conquered regions. One common feature Hellenistic states shared was a commitment to record keeping and complex bureaucratic practices. States, including kings, confederacies and city-states, produced hundreds of thousands of documents written mostly on papyri in Greek, but others on parchment or cuneiform tablets and in various local languages. These documents were sealed with impressions from signet rings or stamps. They were stored in various types of archives [2–4] – ranging from the large official archive at Seleucia-on-the Tigris, Babylonia (25,000 + sealings) to the small household archive in Elephantine, Egypt (35 sealings).

Most of the documents have been lost to the elements, but many thousands of the sealings once attached to them do survive. These sealings were created by impressing signet rings, decorated with images, or seal stamps in clay or bitumen. They derive from the personal seals of private individuals, the official seals of cities and institution, the signet rings of the ruling dynasts or their officers – mainly those of the Seleucids in Syria and Asia Minor, and the Ptolemies in Egypt. These impressions therefore illustrate the choices individuals and institutions made in presenting their (often mixed) identity and status, the royal manipulation of local and imperial iconography, as well as the complexities of administrative procedures and the variety of archival practices used in different regions.

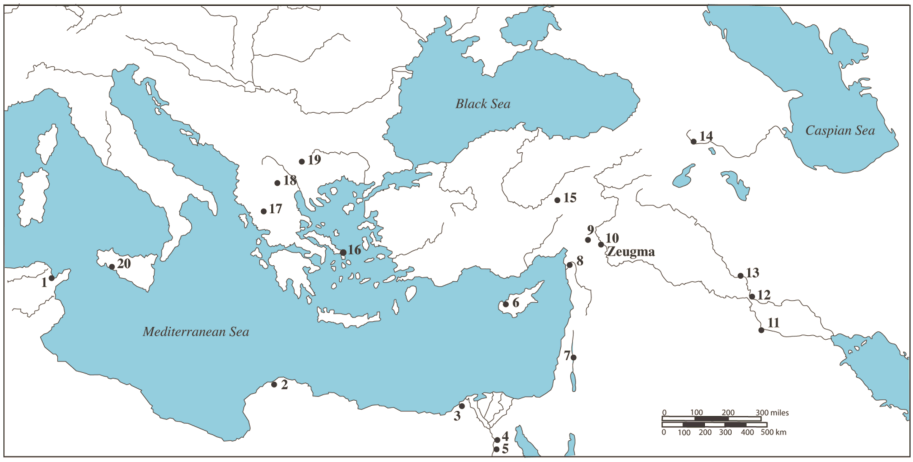

Fig. 1. Map of the Hellenistic World with main sites of hoards of sealings

The hoards of sealings included in the SigNet project were found in the Greek island of Delos, the temple of Horus at Edfu as well as Elephantine in southern Egypt, Tel Kedesh in Israel near Tyre, and Seleucia in Mesopotamia near Babylon. It was also in the Hellenistic period that coinage was adopted as an official monetary and fiscal instrument across the Near East and in Egypt. The overlap in the iconography of sealings and coinage allows for a beneficial comparison for the intensity and extension of certain images. Conversely, differences in the typology of coins and seals offer insight in the regional significance of images.

Combining Hellenistic hoards of sealings found at different sites into a single research project – rather than studying series separately – will significantly improve scholarly insights into sealing and archival practices. Recent scholarship has made important advances in the study of archival practices and the buildings in which archives were housed. Some works encompass a wide geographical and chronological range following a cross-cultural and/or archeological approach, but many rely mostly on textual evidence. Researchers address a complex range of questions such as the gradual differentiation between archives and libraries, the significance of record-keeping, and the distinction between private and public archives. Hoards of sealings add invaluable information for interpretation as they are often the only remains directly linked to the archives, and provide information about the owners or users and thus the nature of the archive.

When studied in the systematic way proposed by the SigNet Project, Hellenistic sealings allow scholars to offer hypotheses on the nature of archives and their content, as well as to draw comparisons between archives and practices across distant regions and strata of the various societies. The study of surviving seal impressions is therefore imperative for the better understanding of ancient administration and the networks of contact between archives, as well as the political implications of the impressed images themselves.

2.2 The Context: Sealings, Administration, Culture and Art

The Hellenistic kingdoms established after the death of Alexander the Great employed skilled engravers to create often elaborate artifacts, which were central to the way in which fiscal and administrative business was monitored, recorded and enacted. As a result, large caches of official sealings and coins have been found from the Aegean to Afghanistan providing an abundance of material for comparison and analysis. Seals were most commonly made in the form of signet rings, either fully made of metal or inset with a stone or glass bezel [1]. Small-scale engravings in stone or metal were widely employed in private practice, both for the administration of households and businesses, but also for simple adornment as jewelry. These uses of engraved items in the private sphere both expand and complicate approaches to this material.

For generations scholars have studied coins, sealings, gemstones [5] and signet rings separately. This isolation of the research reflects in part different functions and purposes of small-scale and miniature media – *e.g.*, personal adornment, fiscal bureaucracy or state administration. However, the division obscures the existing connections between these artifacts – *e.g.*, in creation, imagery and significance. Scholars have yet to determine, for instance, if the same engravers were employed to carve gems, seals and coin dies. Any answer to that question, positive or negative, would tell us a great deal about interactions between public and private spheres, the organization of administrative practices, and artistic traditions.

At the administrative level, identifying links between seals, sealings and coins, could tell us much about the scope and scale of fiscal and managerial practices. No concerted effort to date has been made to study the broad spectrum of ancient engravings, in part because of the sheer abundance of the material and the interdisciplinary effort it requires. The results of such an endeavor are nonetheless sure to be transformative: new networks and interconnections between merchants, administrators, artists, and governments will be found.

The SigNet Project therefore aims to both broaden and deepen our understanding of the ancient world by testing this large set of interrelated evidence in terms of big-data analyses: key factors for this approach are aggregating multiple existing open databases, enriching and standardizing metadata, and developing digital tools to enhance machine-readable queries. The serial nature of the evidence is particularly suitable for this methodology. The following section explores more in detail the digital solutions foreseen by SigNet and their interaction with the existing ecosystem in the field of the digital analysis of miniature and small scale iconographic media.

2.3 Digital Tools Developed by the SigNet Project

There are two main digital tools that SigNet will use to organize existing sealing and coin databases. The first is software developed for the study of coin dies. This state-of-the-art computer technology will establish links between sealings, both within a single archive and between hoards from different – even distant – sites. The tool will moreover establish links between coins and seals or sealings. Digitization is performed through high definition 2D and 3D scanning techniques to reveal stylistic

and artistic details – difficult to observe by the human eye – that could match similar types, recognize fragments from complete images, and even associate artifacts produced at the same workshop or by the same hand (Fig. 2). Overall, this computer-aided study will considerably speed up cross-referential analysis, as the process of establishing links between tens if not hundreds of thousands of items is painstakingly time-consuming – if not impossible – when done by individual scholars or even groups of experts.

Fig. 2. 3D scan of seal impression with the portrait of Cleopatra VII (APM inv. no. 8177-056)

The second tool within the SigNet Project is an open-access website that will allow users to cross-reference items within the selected hoards of seal impressions from Hellenistic archives and the numismatic collections. This overarching SigNet website will make the sharing and study of the source material more efficient. For, it will not only allow quick image comparison of impressions and coins, but will also provide metadata for analysis. The combined database will therefore improve our understanding of the relation between works of art and political propaganda, the circulation of iconographic types from different and distant centers of production, and thus the geographic diffusion of aspects of ideology and symbolism. In all, the repository will address questions about archival and administrative practices as well as the relations between artists and clients.

We expect that SigNet repository will provide an invaluable resource not only for the research of currently unpublished hoards of Hellenistic sealings, but also for advancing the scholarship on ancient seals, sealings and archives in general. Consequent advances in the study of ancient sealings will have its inevitable effect on the separate studies of contemporary coins, signet rings, seals and gemstones. The expected target groups therefore include experts in sigillography and related specializations, *viz.*, glyptic and numismatic studies; colleagues in more broadly related fields such as archaeology and ancient history, Egyptology and Assyriology, epigraphy and papyrology, classics and art history; scientific institutions; museums; and a larger audience of the interested general public.

3 The SigNet Research Ecosystem

3.1 Towards a Cross-Media Study of Sealings and Coins

The iconography of many sealings share features with the coin types of Hellenistic kingdoms and those produced by city-states. Like the sealings, coins were the product of an administrative process, perhaps in some cases related processes. Until now coins, seals and sealings have been studied in isolation by separate groups of experts. While the coins have been extensively studied and published, the sealings have been largely underexploited. One goal of this project is to form the first collaborative effort to bring these disparate groups of scholars together and shed light on the administrative practices of the Hellenistic world, as well as on the use of artistic media in these practices. Sigillography greatly benefits from comparative analyses of the imagery and styles of various miniature and small-scale media, such as contemporary coins, engraved gemstones, signet rings, seals and seal impressions from other sites and times. Such large-scale qualitative analyses provide useful information about specific aspects of the artistic milieus, administrative practices, political ideology and religious symbolism of the Hellenistic Mediterranean and Near East. Examining the influence of different local styles and traditions upon each other in the production of novel iconographic types will expose the complex interaction within the multicultural milieu of the Hellenistic period.

The data-sets available for the study of Hellenistic sealings and archives such as intended by the SigNet project are considerable and sizeable (Fig. 3). Of the roughly twenty archives of sealings of purely Hellenistic date, this project focusses on three of the largest, which were found in stratified excavations, and number well over 50,000 sealings. These include Seleucia's official archive (25,000+), a merchant's archive from Delos (*ca.* 27,500) and an administrative center in Tel Kedesh (2,000+). Included is also an important temple archive from Edfu (*ca.* 750) and the small household archive from Elephantine (35) in southern Egypt.

In addition, the project gains access to the American Numismatic Society's numismatic online database, which consists of over 25,000 coins of Hellenistic dynasts and nearly as many civic coins. All the sealings will have been digitized by the start of the project. All told, the combined objects from these collections amount to some 100,000 coins and sealings. Bringing together the information obtained from separate studies into a single platform of Hellenistic sealings and coins will offer new insights into

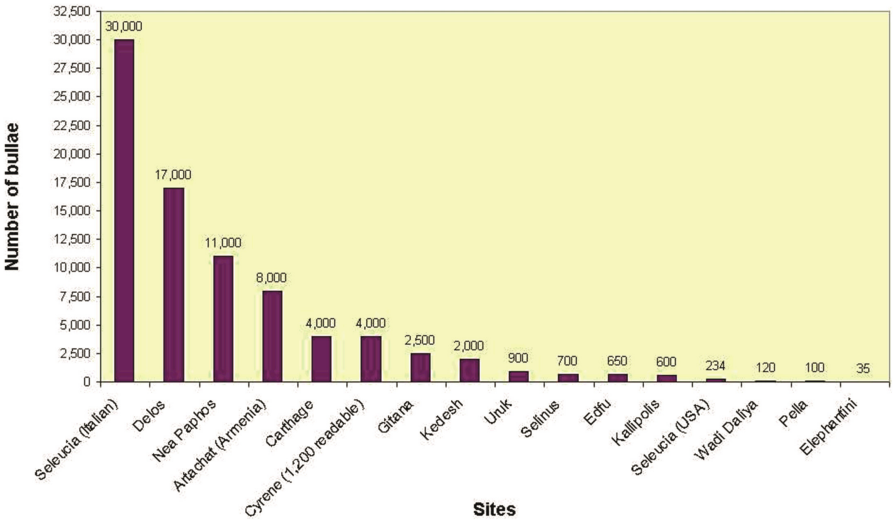

Fig. 3. Table of approximate numbers of sealings per hoard

questions of chronology, iconography, mass production and diffusion, archival procedures, as well as political and social history.

3.2 Interaction and Integration with Other Existing Platforms

The multifunctional SigNet portal will link information from the different existing data-sets in a novel way. The website will adhere to, and contribute to the improvement of, standards for open linked data, with reference vocabularies [6] and metadata compliant with cultural heritage ontologies and semantic models, thus making the material much more widely available for other research questions. The experience of leading actors in the field of the digitization of cultural heritage, such as the Europeana Foundation[3] and its partner project EAGLE (which has now turned into IDEA, International Digital Epigraphy Association)[4], will play an important role in the implementation and fine-tuning of the data-management model. Collaboration with these and other institutions and networks will therefore be actively sought. With regard to reuse permission, a crucial asset of the SigNet Project is that it directly involves the institutions owning the rights of the selected hoards of Hellenistic sealings from Delos, Seleucia, Kedesh and Edfu. These collections will therefore be accessible through a common licensing agreement and available through open access – similar to the ANS platforms discussed below, which have implemented a CC-BY-NC 4.0 International (Attribution-NonCommercial 4.0 International)[5] licensing policy for the pictures of coins. By making its data-sets available over the internet to any user for free, SigNet will prove to be an invaluable

[3] http://www.europeana.eu.

tool for humanists and social scientists exploring the multiple cross-cultural interactions that took place in the polities which developed after Alexander conquest of the East. We expect that our commitment to an open-access policy will not only considerably foster connectivity with other specialized platforms (such as Trismegistos and Eagle Media-Wiki), but also promote reuse in fields of digital media for cultural and educational institutions.

Collaboration with the American Numismatic Society will play a prominent role in the implementation of the SigNet Consortium's vision, both within and outside the project discussed here. The ANS numismatic online database (MANTIS)[6] is already available as an invaluable comparative resource including about 50,000 Hellenistic coins. In recent years, the ANS has been at the vanguard in the development of online digital resources. ANS sites are built around the Numishare platform, which is based on policies of open access and linked data concepts, and employs the terminology and ontology of nomisma.org. The ANS portal PELLA[7] provides typologies of the coinages of Alexander the Great, with links to examples found in half a dozen collections worldwide. In addition, the site provides mapping information on where the types were minted and where specimens have been found in hoards. The ANS is presently embarking on a large-scale project involving Hellenistic royal coinage, which will result in a number of parallel portals each focusing on individual dynasties, *e.g.*, the Seleucids, the Ptolemies, etc. Information about provenance, date, type and so forth will be readily available for the SigNet portal, either through MANTIS or sister sites.

4 New Frontiers of Dissemination: Academic Research and Digital Cultural Heritage

The partners of the SigNet Project share the vision that stimulating collaborative, interdisciplinary digital scholarship is an essential step to ensure significant advancement in research, cut down human and economic costs and make dissemination of research results effective. However, communication among experts and between related academic fields is not the only goal of the project. In compliance with current attempts of scientific research in humanities and social sciences to reach out to the larger society, SigNet recognizes the importance of promoting dissemination to the widest possible circulation. This effort consists of integrating the material as well as research into the broader field of cultural heritage, in order to make them available to the general public of cultural and educational institutions and organizations.

A readily and easily accessible web application available to the general interested public will allow a larger web community – well beyond the handful of scientific specialists – to become involved and share insights. Computer generated comparisons based on user search commands will analyze similarities within existing digital image

[4] http://www.eagle-network.eu.
[5] https://creativecommons.org/licenses/by-nc/4.0/legalcode.
[6] http://numismatics.org.
[7] http://numismatics.org/pella.

databases of seal impressions and coins. Such an innovative research tool will unquestionably lead to new insights. Registered users will be invited to add metadata to existing entries and/or upload similar artifacts. Thousands of engraved gems survive, mostly from undocumented excavations or old private collections. Evidence from sealing collections, archives and hoards will significantly benefit the study of ancient glyptics at large, which remains a highly speculative and under-documented field. Here too, adaptation to existing guidelines and good practices shared by leading international networks (*cf*. Europeana, Civic Epistemologies[8], RICHES[9]) will combine into an active collaboration among professionals from cultural and educational institutions who will share research insight through user engagement, digital storytelling and citizen science.

Collaboration will also be sought and promoted with Wikimedia[10] in order to develop outreach projects in schools and museums. A whole set of tools, from photo scavenger hunts to edit-a-thons and more structured Wikidata projects,[11] are available to engage students, museum professionals and interested citizens in a shared goal: making miniature iconographic objects convey their stories and contribute to the understanding of the multi-faceted life of the ancient world and, through comparisons, of the many other historical contexts – up to present day – in which coins and sealings play a role in everyday life.

In the future, the partners of the SigNet Project aim to establish an even larger consortium with the dual purpose of further augmenting and connecting the SigNet repository with similar databases across the world, and of coordinating and promoting individual initiative, group efforts such as edit-a-thons, and future subsidized projects concerning collections of ancient signet rings, engraved gems, seals and other collections of sealings. This commitment will assure that the web applications developed by the SigNet Project will keep on growing and facing the new challenges of research, museum engagement and citizen science for many years to come.

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