The Authenticity of the Bullae of Berekhyahu Son of Neriyahu the Scribe

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Bullae are small lumps of clay, often fingernail-sized and shaped as flat disks, which were usually affixed to a cord binding a commodity or a document and then stamped with a seal. Hebrew bullae from the time of the Kingdom of Judah are known from recorded excavations as well as from the antiquities market. This article reports the results of a set of analyses that were made of two celebrated bullae attributed to Berekhyahu (Baruch) son of Neriyahu, the scribe to the prophet Jeremiah mentioned in Jer 36:1–4. These results were compared with similar analyses of more than 180 bullae, most of them from Jerusalem. The results of the comparision, together with their interpretations, are presented, pointing to the production of the two Berekhyahu bullae in modern times.

Introduction[1]

Little has been preserved in the archaeological record from the rich literary material of the kingdom of Judah (**Fig. 1**). Despite the discovery of some contemporary written sources, such as ostraca and seals, it may be assumed that many of the documents were written on scrolls or papyri that have not survived. Consequently, most of the scholarly records from this period often referred to in the biblical sources have been lost forever. Only some meager remains of these texts have been preserved in the form of bullae—namely, the clay sealings that were once attached to papyri. Bullae are small lumps of clay, often fingernail-sized and shaped as flat disks. They were often affixed to a cord binding a papyrus document and then stamped with a seal. Other bullae apparently sealed basketry or fabrics, most likely small bags containing commodities, evident by the impressions on their reverse sides. A few bullae probably functioned as tokens, having no cord impressions or fabric or papyrus imprint (Avigad 1986: 13–14).

Only a relatively small number of bullae have been found in the course of over a century of archaeological exploration at the major Iron Age sites of Judah, until the turn of the 21st century (Avigad 1997: 167–241). However, during the last decade, the number of bullae found in recorded archaeological excavations, particularly in Jerusalem, has been steadily increasing for several reasons. First, due to their small size, such tiny clay objects can easily escape the attention of inexperienced students who do not search specifically for them. But in some recent excavations, there has been a concerted effort to watch for them. Moreover, careful sifting was not always a common practice in many past excavations of the major Judahite Iron Age sites, most likely causing the loss of many of these tiny objects. Nevertheless, the introduction of wet sieving (a method already used for decades in prehistoric research) in many excavations during the

[1] The study of the bullae mentioned here as Berekhyahu 1 and Gealiyahu was carried out in the Israel Museum in Jerusalem. The study of Berekhyahu 2 by the first author was made per the request of Mr. Shukka Dorfman, the late general director of the Israel Antiquities Authority (IAA), and Mr. Amir Ganor, who was then in charge of the Antiquities Looting Control Unit of the IAA, as part of a police investigation that focused on several alleged archaeological forgeries.

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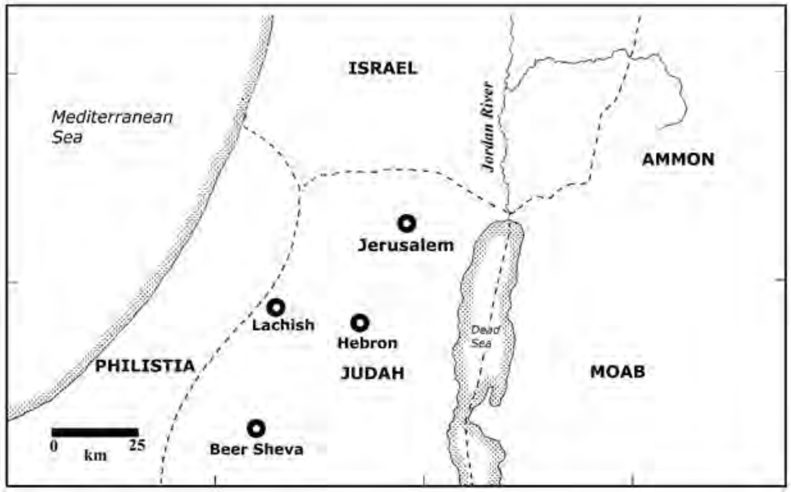

Fig. 1. Jerusalem and the boundaries of Judah in the Late Iron Age.

last decade had immediate effects. Consequently, 20 years after the discovery of merely 51 Iron Age bullae in Jerusalem, all in one room in the Shiloh excavations, the newly adopted archaeological methods resulted in the discovery of hundreds of additional bullae. Within only a few years, over 170 bullae from the excavations of Ronny Reich and Eli Shukron (Reich, Shukron, and Lernau 2007: 156–57; 2009) and over 200 bullae from Eilat Mazar's excavations (Mazar 2009: 69, and pers. comm.) have come to light. It seems that, in this respect, professional archaeologists were no less responsible for the previous dearth of provenanced Judahite bullae before the 21st century than were the site looters and the demand by the antiquities market.

The bullae uncovered in well-recorded stratigraphic contexts of controlled excavations are among the most important discoveries made in Iron Age strata in Israel. At the same time, still larger numbers of unprovenanced bullae are known from the antiquities market. Tracking back their occurrence, it seems that most of the large collections emerged as assemblages appearing generally after the Six-Day War (1967), through to the turn of the century, with major peaks occurring during the early 1970s and the late 1980s. The forgeries trial that occurred in Israel between 2004 and 2013 has seemingly affected this flourishing trade, most likely as a result of the increasing awareness of the existence of forgeries and the decline in the demand for palaeo-Hebrew epigraphs.[2] Thus, the largest collections of unprovenanced Judahite bullae appeared in the antiquities market between ca. 1970 and 2000. Of these, the most notable were the lots from the Reuven Hecht and Yoav Sasson collections published by Avigad (1986; 1997), the Josef Chaim Kaufman, and Shlomo Moussaieff collections published by Deutsch (2003a; 2003b), and a few other known lots. Unknown numbers of other Iron Age bullae are kept in additional private collections and smaller museums.

Two of these unprovenanced bullae are of particular interest. In 1975, a bulla appeared in the antiquities market, stamped with an oval seal 13 × 11 mm in size (**Fig. 2: left**). The inscription, written in palaeo-Hebrew, reads: *lbrkyhw bn nryhw hspr* ([belonging] to Berekhyahu son of Neriyahu the scribe). This bulla (hereafter Berekhyahu 1) was purportedly sealed by Baruch son of Neriyah, the scribe to the prophet Jeremiah mentioned in Jer 36:1–4 (see also Rollston in press). This bulla was published by Avigad (1978; 1979; 1986: 27–28; 1997) by permit of its purchaser, the Israeli businessman, donor, and antiquities collector Dr. Reuven Hecht. This bulla was donated by Hecht in 1976 to the Israel Museum in Jerusalem and has been thereafter part of its collections (reg. no. IMJ 76.22.2299). While the source of the bulla may never be revealed, some rumors connected it with the "burnt house" excavated by Shiloh in the City of David where, as mentioned above, other bullae were retrieved in the course of legal excavations (Shiloh 1984: 19–20; 1986; Shiloh and Tarler 1986). But there were other narratives linking it with different assumed circumstances of discovery (see Rollston in press). In 1996, a second clay bulla surfaced in the antiquities market with an identical inscription (hereafter Berekhyahu 2), apparently stamped by the same seal (**Fig. 2: right**). This specimen is kept now in the Moussaieff collection in London.

[2] Pers. comm. with three antiquities dealers from Jerusalem.

Fig. 2. The two bullae of Berekhyahu son of Neriyahu the scribe, as viewed from the sealed and reverse sides. Left: Berekhyahu 1; right: Berekhyahu 2 (photo by the authors).

Over the years, the two Berekhyahu bullae ignited much excitement, allegedly for being two of the main (though not the only) Iron Age epigraphs bearing familiar biblical names. Indeed, among the many personal names appearing on Iron Age bullae from legal excavations, there are some belonging to figures known from the Bible. Such are, for example, two names appearing on the bullae from Area G in the City of David, including Gemaryahu son of Shaphan (Shoam 2000: 33, B 2), a high official in the court of King Jehoiakim, and Azaryahu son of Ḥilkiyahu (Shoam 2000: 43, B 27), probably a member of a priestly family mentioned in the Books of Chronicles (Schneider 1988). From Lachish, where a group of 17 bullae was discovered inside a pottery juglet (Aharoni 1975: 19–22, pl. 47:27), one bulla bears the name of Shevanyahu, the servant or son of the king (Aharoni 1975: 21, pl. 20:5), clearly a high official operating within the administrative or clerical system of Judah. Several other names of high officials, sometimes familiar from the Bible, also appear on some as yet unpublished bullae from the more recent excavations in Jerusalem (Mazar 2007). However, the Berekhyahu bullae are directly related to a prophetic figure—the scribe and friend of Jeremiah, according to one interpretation, or the royal scribe, according to another—and hence are of special interest. As such, they have ignited considerable excitement, especially in the popular archaeological literature. The March/April 1996 issue of *Biblical Archeology Review* featured an article on Berekhyahu 2, referring to the clear impression of a fingerprint on the upper left side of it as the "fingerprint of

Jeremiah's scribe" (Shanks 1996). More recently, the two Berekhyahu bullae were ranked fifth out of the ten major archaeological discoveries of the past century relating to the biblical world, inferior only to the Dead Sea scrolls, the Tel Dan inscription, the "Ketef Hinnom" amulets, and the Galilee boat (Schoville 2002).

During the last decade, a research project applying systematic laboratory examinations on numerous Judahite bullae from recorded excavations in Jerusalem and other Judahite sites has been carried out in the Laboratory for Comparative Microarchaeology at Tel Aviv University (Arie, Goren, and Samat 2011; Gadot, Goren, and Lipschits 2013; Goren and Gurwin 2013; Goren, Gurwin, and Arie 2014; Gurwin, Goren, and Lipschits in press).[3] This study was aimed at providing analyses of some as yet undetermined technical aspects of the Judahite bullae. Since it is widely believed that bullae were used to seal documents or small parcels issued by certain authorities, ensuring the discreet reading of a message or the opening of the parcel only by authorized individuals, the first attempt was aimed at disclosing the geographical origin of the bullae through the composition and probable provenience of their clays, in order to map the administrative network of Judah during the middle to the end of the Iron Age. This was based on the common assumption that bullae could have sealed letters or clerical documents written on papyri, which were then circulated within the closed system of the Judahite bureaucracy. Therefore, the initial question was whether the material composition of a given assemblage of bullae would reflect sufficient similarity to justify their assignment to a single site, or whether the analysis would show that they were made of clay from different locations. To this end, minute samples were extracted from the bullae by the peeling technique (see Goren, Finkelstein, and Na'aman 2004: 11–12 for the technical details), and examined in thin sections under the petrographic microscope. The petrographic definition of each sample was then supported by physical and chemical examinations under a variable vacuum ("environmental") scanning electron microscope (SEM). In addition, the structural and technical aspects of the bullae were examined based on surface observations under a stereomicroscope, with magnifications ranging between 10× and 100×. These were made in order to record minute details of the "substrate" (namely, the papyrus, fabric, or parchment to which the bulla was secured), the cord impressions, the fingerprints and other imprints, and of course the seal impressions. These examinations attempted to address some technical questions, such as the general nature and fine details of the typical formation processes of bullae in Iron Age Judah.

The bullae studied in this research in petrographic thin sections and under the SEM include 36 bullae from a group comprising 51 items, uncovered in Area G at the City of David by Shiloh (1984: 19–20; 1986; Shiloh and Tarler 1986; Shoham 2000; Brandl 2000), two bullae found by the British expedition at Lachish (Tufnell 1953: 348; pls. 44A:172–73; 45:172–73), an assemblage of 17 bullae discovered by Aharoni at Lachish (Aharoni 1975: 19–22, pls. 20–21), and another bulla retrieved from Beth-Zur (Sellers and Albright 1931: 8–9). In addition, 85 of the bullae discovered in E. Mazar's excavations in the City of David (Mazar 2007: 67–69) were analyzed (Gurwin 2010), together with 45 items out of the nearly 170 bullae discovered near the Gihon Spring in the City of David, dating to the late ninth–eighth centuries B.C.E. (Reich, Shukron, and Lernau 2007: 156–57). All these form the main reference group for the present study, including altogether 186 bullae, all from legal excavations and recorded provenance. To this, we may add similar analyses of about 100 more unprovenanced bullae from several private collections, including 20 bullae from the Yoav Sasson collection published by Avigad (1986). This study was complemented by the analysis of 22 bullae associated with the "Samaria Papyri" from a cave in Wadi ed-Daliyeh, dated to the middle third of the fourth century B.C.E. (Gurwin, Goren, and Lipschits in press).

The results of this study revealed many aspects, some of which had gone unnoticed previously, concerning the technology of bullae production by the Judahite scribes during the ninth to sixth centuries B.C.E. These results have some significant implications that affect our understanding of the role of clay bullae in the clerical and bureaucratic administrative system of the later part of the Iron Age (Arie, Goren, and Samet 2011; Goren and Gurwin 2013; Goren, Gurwin, and Arie 2014). With these details in mind, it is only natural to address now some of the most intriguing unprovenanced bullae discussed in the literature, including the two above-mentioned bullae ascribed to Berekhyahu son of Neriyahu the scribe.[4] Given this

[3] The authors gratefully acknowledge funding for this project from the Horowitz Foundation on behalf of the Interdisciplinary Center for the Conservation and Study of Historical Heritage in Israel (ESHMOR), and the Early Israel framework on behalf of the New Horizons program of Tel Aviv University. The follow-up of this research is supported by Israel Science Foundation (ISF) grant no. 947/12 entitled "The Administration of Judah under Assyrian, Babylonian and Persian Rule." A major part of the study of the provenance of bullae from Jerusalem was undertaken by Ms. Shira Gurwin, now at the Eretz-Israel Museum in Tel Aviv, as part of her M.A. thesis done under the supervision of the first author and Oded Lipschits. We are grateful to Eilat Mazar from the Hebrew University of Jerusalem; Ronny Reich from the Zinman Institute of Archaeology, Haifa University; and Eli Shukron, Fawzi Ibrahim, Debi Ben-Ami, Hava Katz, and Michael Saban of the Israel Antiquities Authority for enabling us to study these bullae.

[4] The two bullae of Berekhyahu son of Neriyahu the scribe were examined between 2004 and 2013. Berekhyahu 2 was studied by request and special appointment issued by Mr. Shukka Dorfman, director of

background, such comparison can address several questions concerning their possible provenance, technology, and presumed authenticity. For reasons explained below, we decided to add a third bulla, bearing the seal impression reading: *lg'lyhw bn hmlk* ([belonging] to Gealiyahu son of the King [Avigad 1986: no. 6, Israel Museum reg. no. IMJ 76.22.2301]), henceforth referred to as Gealiyahu 1.

Formation Process

Microscopic study of the reverse sides and edges of over 200 bullae from legally controlled excavations revealed the imprint of the substrate material, which from the eighth century B.C.E. onward was almost always papyrus, and the cord that had tied it around the document to which the clay bulla had been attached. This basic feature has already been noted by numerous scholars dealing with the matter. However, relatively little attention has been directed toward the process of bullae production, as reflected by the microscopic details of the sealings. It is clear that some of the discussions of the way bullae were used to seal documents were influenced by the more current use of sealing wax, by some misguided preconceptions, or merely by some poor observation apparently with the aid of low-powered magnifiers. Sadly, this myopia appears in the introduction to the influential book by Avigad (1986) as well as other publications. However, the properties of wax are completely different from those of clay, and, in contrast to pottery production, for example, the technology of attaching clay bullae over papyri, fabrics, parchment, and the like is now extinct, and our knowledge cannot be supported by any ethnographic or other analogical data. Nevertheless, the examination of the bullae under a common stereomicroscope can be very telling and can reveal many facts. When examined under such equipment, two types of cord impressions can usually be distinguished on the reverse side of the bullae: hollows created by cords that were completely embedded in the clay (**Fig. 3:1**), and a set of impressions of cords that were not completely encased by the clay but only impressed into it (**Fig. 3:2**). These sets of cord impressions were separated by the two different disk-shaped layers of clay, which were put one above the other when wet, with the cord rolled between them and under the lower one (**Fig. 4**). In the process, fingerprint marks were often left around the edges, reflecting a series of pressings made in shaping the final contour of the sealing and often blurring the contact line between the clay layers.

To be sure, the original users of the clay bullae were as much concerned about their authenticity as present-day museum curators, archaeologists, and antiquities collectors. Hence, this rather complicated shaping method was employed specifically to prevent the fraudulent removal and manipulation of bullae from the documents they sealed. Because bullae served as certificates, or the equivalent of today's signature combined with a logo heading, measures had to be taken to prevent fraud. Because the results of our recent studies suggest that in most (if not all) cases, epigraphic bullae were used from the eighth century B.C.E. onward to seal legal documents and contracts, rather than letters (Arie, Goren, and Samet 2011; Goren and Gurwin 2013), the formation of a bulla around a sealed document as well as its treatment after removal from it needed to be made in a sophisticated way that would ensure the complete association between the bulla and the cord. This fact was apparently underestimated by past scholars (i.e., Avigad 1986; 1997), who presented an overly simplistic view of the way bullae were constructed and utilized.

The credit for first noticing the complexity of bulla formation, or at least discussing it in the literature, should be given to Baruch Brandl. In an attempt to explain the possible method used to form the bullae from Shiloh's excavations, Brandl (2000) suggested that they were made of an elongated, flat, ovoid lump of clay. This lump was placed over the cord that had been rolled several times around the papyrus. Then the cord was tied over the clay, which in turn was folded over the knot and pressed in order to seal it. Then the clay was sealed while still wet and set to harden. Brandl's observations represent the first attempt to examine closely the pattern of bulla construction through careful study of their details. Yet our microscopic examinations and simulations with clay, papyrus, and ad hoc seals made of dentists' wax (**Fig. 5:1**) revealed a somewhat different pattern (Arie, Goren, and Samet 2011), which can be summarized as follows: First, the papyrus document was folded into a flat elongated rectangle (**Fig. 5:2**, showing it by mistake as rolled). The cord was then wrapped around it several times (**Fig. 5:3**). Next, a flat lump of clay was pressed against the cord (**Fig. 5:4**). The cord was then wrapped several times around both the papyrus and the lump of clay (**Fig. 5:5**). After this, another flat lump of clay was placed over both the cord and the first lump and pressed onto them (**Fig. 5:6**). The top of the two-tiered lump of clay with string in the middle was then impressed with the sealing ring (**Fig. 5:7**). While the ring was still pressed into the clay, the edges of the bulla were smoothed by fingers, leaving a set of fingerprints all around (**Fig. 5:8**). The seal was then removed, leaving the clay bulla securely

the Israel Antiquities Authority (IAA), as part of the investigation of selected artifacts from the antiquities market. Berekhyahu 1 was studied after a written request was sent to one of the authors (YG) on December 23, 2008 by Ms. Michal Dayagi-Mendels, then the chief curator of archaeology in the Israel Museum, Jerusalem. It was reevaluated after a request by the second author after his appointment as curator of the Iron Age in the Israel Museum in Jerusalem.

Fig. 3. Close-up view under the stereomicroscope of a typical Judahite bulla viewed from the lateral side, showing the papyrus impression and two sets of cord imprints, one crossing the bulla internally (1) and the other partly pressed into the lateral side (2) (photo: Y. Goren).

Fig. 4. Close-up of the two sides of the bulla of Hilkiyahu son of Ma'as, discovered in Starkey's excavations at Lachish. Note the two clay layers, which were put slightly offset and thus can be seen from both sides (photo: Y. Goren).

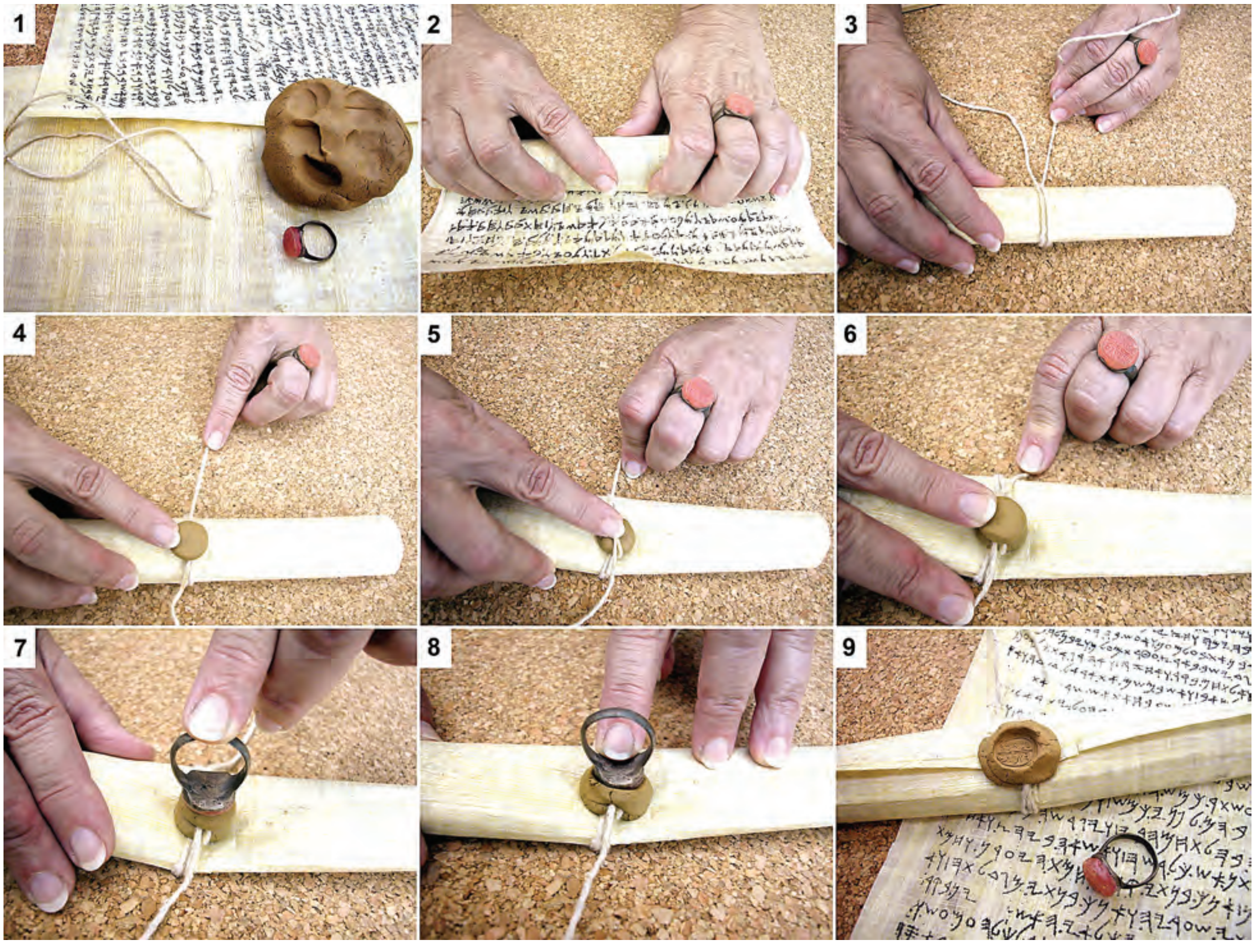

Fig. 5. Simulation of the production process of a Judahite bulla (see the text for details) (photo: Y. Goren, hand modeling by Nettah Halperin).

attached to the folded and tied document (**Fig. 5:9**). After drying, it became impossible to open the document without breaking the bulla or cutting the cord. Our examinations indicate that all the Iron Age bullae bearing papyrus impressions from documented and legally controlled excavations that we have examined thus far were formed by this method. In several cases, when the two lumps of clay were placed slightly offset, the border between them can be clearly seen either on the reverse or the side of the bulla (**Fig. 4**). These steps seem to have escaped the attention of most scholars who have previously studied Judahite bullae (i.e., Avigad 1986: 13–14; 1997: 31–41; Deutsch 1999: 13–16).

The study of the two Berekhyahu bullae under the stereomicroscope indicates that while they are identical to each other in terms of their formation process, they differ significantly from the above-described chain of operations that typifies the excavated Judahite bullae. A general look at their lateral side (**Fig. 6**) reveals that they both engulfed only a single cord and, significantly, a crude one as opposed to the delicate strings that left their impressions in most of the provenanced bullae that we analyzed. The thick and clumsy cord in Berekhyahu 1 and 2 penetrates through the clay at about the center of their thickness from one side to about two-thirds of their diameter, then pulls out and forms a loop that is partly pressed into the clay in the opposite direction. After the loop the cord was unraveled to its fibers, indicating that this part was near the end of the cord. This phenomenon can be seen on both Berekhyahu 1 and 2 under somewhat higher magnifications, especially when the lateral side is inspected from an oblique angle parallel to the exit of the cord from the clay (**Fig. 6**). Therefore, as opposed to every other provenanced bulla that was examined thus far, the two Berekhyahu bullae had to be hanging at the end of a looped and partially unraveled twined cord which penetrated them only partially, from the edge to slightly after the center of the unstamped side. Yet at the same time, these were not "hanging sealings,"

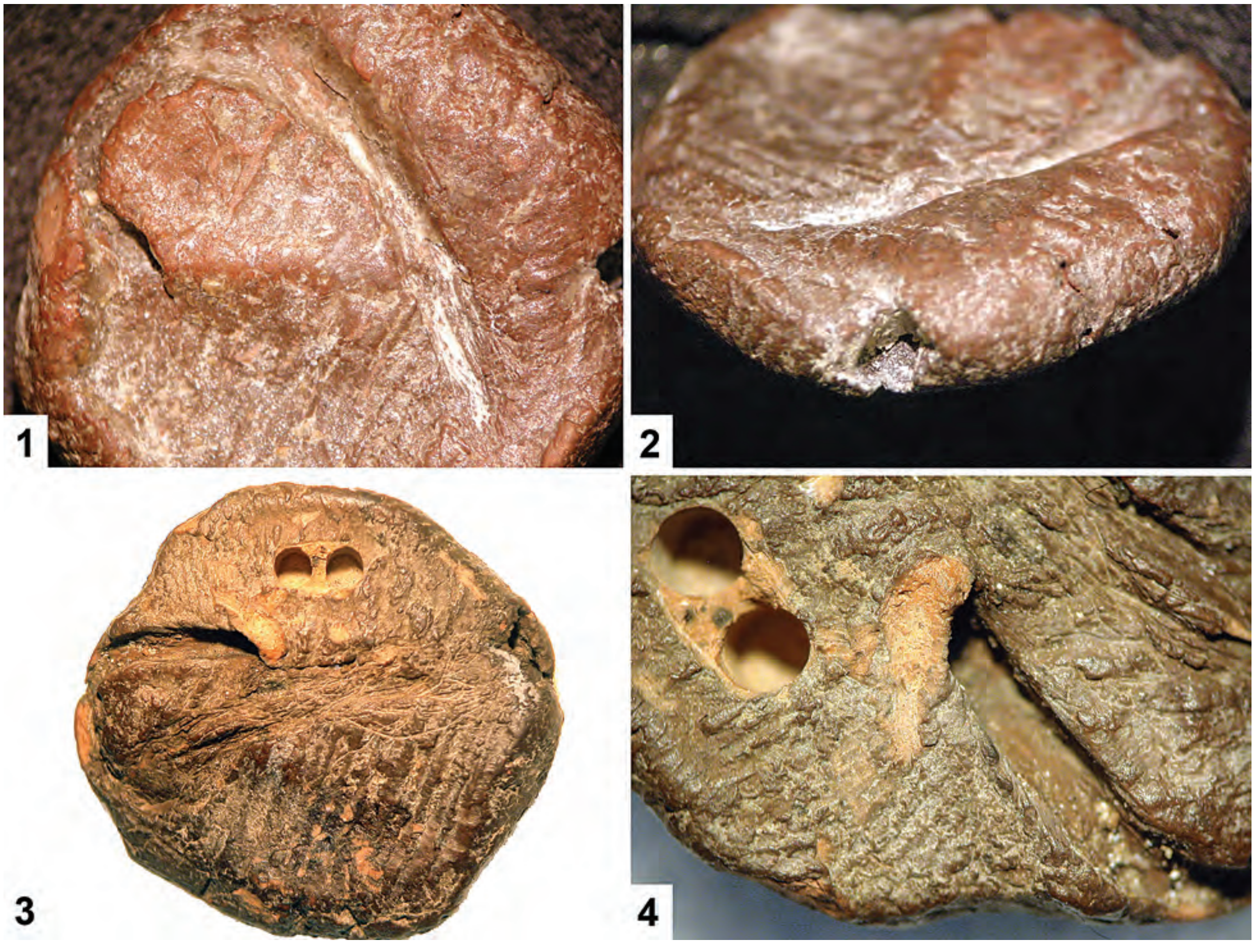

Fig. 6. Views under the stereomicroscope of the lateral side of Berekhyahu 1 (Photos 1–2) and Berekhyahu 2 (Photos 3–4), showing the unusual cord and papyrus impressions (photo: Y. Goren). The two holes in Berekhyahu 2 were reportedly made by a TL laboratory with no further details.

because the impression of a coarse-fabric papyrus on their reverse, to be discussed later, indicates that they were allegedly attached to a document of some kind. This anomalous feature did not escape the attention of Avigad (1986: 19; 1997: 175–76), who commented, "The string impressions here are curved, and the lumps of clay seem to have been applied to the loops of the knots. These grooves are especially thick and the actual fibers of the string are still extant." Because in this context Avigad referred also to Gealiyahu 1, we examined it too and found exactly the same phenomenon. In fact, it is very difficult to suggest any practical function for this situation, which is unparalleled by any of the bullae found so far in recorded excavations.

Indeed, single-layered bullae enclosing a set of cords appear in the Persian period, in the fourth-century B.C.E. "Samaria Papyri" from Wadi ed-Daliyeh. The papyri and bullae from Wadi ed-Daliyeh offer a unique opportunity to study an assemblage of later specimens, still intact and found with their cord, some even still attached to the papyrus. Together with the Elephantine papyri, this is the only empirical evidence for the standard use of clay bullae during the later Persian period, thus shedding more light on the formation process of bullae in this era as compared with the earlier Iron Age. Technological study of 22 bullae from Wadi ed-Daliyeh (Gurwin, Goren, and Lipschits in press) revealed that, on their reverse side, papyrus imprints and sometimes minute pieces of papyri were seen clinging to the clay or caught in a delicate curve of it. On some of the bullae, a single set of cords was identified, passing through the center of the bulla and around the papyrus, whereas on other bullae, two sets of cords were visible, one running through the center of the bulla and around the papyrus, and the other around the back of the bulla. These two groups, representing different technologies of designing and forming bullae, were recognized through this analysis. The first group displays a "partial securing technology" and includes bullae that have one set of cords passing through the ball of clay. This group of bullae contains only the negative impressions of the material to which they were affixed. This technique of sealing involved pressing one lump of clay against the sealed object, securing both with the cord; after this, another piece of clay was placed over the cord and pressed onto the first lump. The second group displays a "maximal securing technology" and includes bullae that have two separate sets of cords: an internal set, similar to the first group, and an external set that ran along the back of the bullae. These bullae contain both the negative impressions of the material to which they were affixed and the impression of the external cords. This technique of sealing involved wrapping the object with the cord and pressing the first lump of clay against the cord; the cord was then wrapped around both the sealed object and the lump of clay; after this, another piece of clay was placed over the cord and the first lump and pressed onto them. Only then was the document sealed with a sealing ring. However, this practice was not utilized in the Iron Age. Moreover, such bullae were always surrounding a bunch of cords penetrating the clay completely from one side to another and never tied loosely to the end of a single looped twine.

Another significant issue is related to the imprints of the papyrus on the lateral side of the bullae. In contrast to all the provenanced bullae that we examined, Berekhyahu 1 and 2 display the imprint of a coarse pattern of parallel grooves, similar to that of a corn leaf, rather than the delicate mesh-type imprint of a common papyrus (cf. **Figs. 2** and **6** with **Figs. 3** and **4**). Because so far we have observed only papyrus imprints on Judahite bullae later than the early eighth century B.C.E. (Gurwin 2010), this imprint on Berekhyahu 1 and 2 stands out as a unique and unparalleled feature. However, it appears also on Gealiyahu 1, as indeed Avigad (1986: 19) noticed.

To sum up, one significant aspect of Berekhyahu 1 and 2 is concerned with their formation process. These bullae are unique in that instead of being formed by the two-clay-layers method, they were created each from a single ball of clay that was applied around the last part of a thick cord, which was bent into a loop near its end. This phenomenon is completely absent in the eighth to sixth centuries B.C.E., when bulla formation was consistently based on the two-layer method. If this was done over a folded papyrus, it is difficult to comprehend how such a bulla could function to seal any document or how it could remain attached to it.

Clay Selection

Based on the petrographic data, combined with the SEM results, the raw material of all the examined bullae from Jerusalem is readily identified as fabrics which are, in fact, Quaternary alluvial beds derived from *Terra Rossa* soils (Arie, Goren, and Samet 2011; Gadot, Goren, and Lipschits 2013; Goren and Gurwin 2013; Goren, Gurwin, and Arie 2014; Gurwin, Goren, and Lipschits in press). The bullae from Lachish were made of local rendzinal soil (Arie, Goren, and Samet 2011). It should be emphasized that none of the Iron Age bullae that we have examined so far were made of clay and marl geological formations, such as the local Moza and Teqiye clay formations, even though these were extensively used for pottery production in Judah throughout the ages (Goren, Finkelstein, and Na'aman 2004, with references therein).

In thin section and under the polarizing microscope, the clay of the bullae from Jerusalem appears to be non-calcareous, ferruginous, and usually silty. This fabric is typified by a reddish-tan to dark matrix in thin section, highly optically active to nearly opaque under crossed polarizers, with silt ranging between 5% (rare) to nearly 20% (common). The silt is mainly quartzitic, but it often contains some accessory heavy minerals, of which hornblende and zircon are the most common. The coarser components, when they exist, are made of fine sand containing mainly quartz or limestone. Other minerals or rock fragments that rarely appear in the inclusions are chert or chalcedony.

Terra Rossa soils occur on hard limestone and dolomite exposures in the semiarid to subhumid Mediterranean climatic zones. This soil material is eroded downslope, forming colluvial-alluvial soils. All the soil materials in Israel include, to varying extents, aeolian silt of desert origin. Carbonate rocks do not contain silt-size quartz grains, but large amounts of such grains occur in the soils that developed on these rocks. In the bullae from Jerusalem, only in a few cases was nearly non-silty *Terra Rossa* used, indicating the employment of soil from an in situ exposure (Arie, Goren, and Samet 2011; Goren and Gurwin 2013). These petrographic examinations were enhanced by the SEM-EDS analyses. The latter were made on the entire surfaces of the bullae rather than on samples extracted from them.

To sum up, both the petrographic and the SEM analyses revealed that all of the bullae from the City of David in Jerusalem were made of *Terra Rossa* soil, having a more or less constant mineralogical composition of silt and temper inclusions. As in the case of the bullae formation processes, it seems that strict epistolary rules dictated this raw material selection, which was intended to ensure that the bullae would dry without shrinking and present clearly the minute details of the seal impression. Because all types of soils in Israel contain some wind-blown silt of desert origin, which acts as delicate natural temper, they tend to be less plastic than purer clays from formations such as the Moza and the Teqiye. Our simulations (such as in **Fig. 5**) revealed that if the clay is too plastic or wet, the seal tends to stick to the clay and produce a blurred impression when pulled back. By using silty clay, which was often sealed when nearly "leather hard," as evident from the cracks that many bullae have on their edges, clear impression could be achieved easily without the clay clinging to the seal. However, for this reason, the bulla could not be simply pasted over the papyrus and the cords, for which reason the two-layer method described above was required.

Petrographic and SEM-EDS examinations of Berekhyahu 1 and 2 indicate that they were made of clay from the Moza formation. This is evident by the contents of dolomitic silt, the high contents of clay and iron minerals, and the fabric affinities as seen in thin section under the polarizing microscope, together with the SEM-EDS results (for further petrographic properties and references to this category, see Goren, Finkelstein, and Na'aman 2004: 263–64). It should be mentioned that the small sample taken from Gealiyahu 1 provided exactly the same results. While clay from this formation was and still is used by potters in Jerusalem and Hebron, it was not used for bullae during the Iron Age. Of course, this notion was not known before our publication of the first material studies ever to be made on Judahite bullae during the first decade of the 21st century (Arie, Goren, and Samet 2011). However, it may be assumed that this technical preference was well known to the Judahite scribes over generations during the Iron Age, as evident by their apparent sole use of this raw material.

Firing

Clay bullae were originally dried but not fired, due to the obvious reason that fire would destroy the documents, the cords, or any organic materials attached and sealed by the bullae. This phenomenon greatly affects the preservation of bullae in the archaeological record, because it is very unlikely that unfired small lumps of clay would survive over millennia in the ground in humid or subhumid climatic zones. For this reason, finding bullae in excavations is generally uncommon. Indeed, recent analyses of Iron Age Judahite bullae from Jerusalem and several other sites, as well as unprovenanced bullae from some private collections, have shown that the vast majority were probably preserved due to their exposure to fire, which brought about their sintering to ceramic phase (Arie, Goren, and Samet 2011; Goren and Gurwin 2013). However, there are some exceptions to this rule. The first is the assemblage of bullae from Wadi ed-Daliyeh, which were originally found still attached to their papyri. This remarkable state of preservation undoubtedly owes its existence to the extremely arid conditions of the desert. Some of the papyri discovered at Elephantine in Upper Egypt (Porten 1992; 1996) similarly still bore their bullae, though they dated somewhat earlier (fifth century B.C.E.). From the Iron Age, the only instance of unfired bullae that we have encountered so far is the small hoard of 17 items that was found in a sealed juglet in Lachish (Arie, Goren, and Samet 2011). The preservation of these unfired bullae, though in relatively poor condition, was undoubtedly due to their unique protection by the intact sealed juglet.

Because many of the Judahite bullae were found in their complete shape, the question arises whether they were still coupled together with their document when fired, or might they have been separated by cutting the cord and firing them intentionally to preserve them for reference. The group of bullae from Lachish undoubtedly indicates that at least some bullae were separated from the documents that they sealed in such a manner, as evidenced by the papyrus impressions on their lateral side, and kept for reference. Yet the fact that they were unfired hints at an unintentional firing in the other cases, rather than deliberate baking.

When tested with a wet brush on a hidden part, the clay of the two Berekhyahu bullae (and also of Gealiyahu 1) retained its plasticity, indicating that it was never fired to a sintering stage. For all the above reasons, and unless these bullae were discovered in extreme arid conditions—a possibility negated by the patina on them (discussed below)—it seems highly unlikely that these artifacts could be authentic.

Patination

When examined under a magnifier or a stereomicroscope, Berekhyahu 1 and 2 and also Gealiyahu 1 appear to be coated by two different materials. The first is a dark, wax-like polish that coats only the surface, as evident by areas where drilling was reportedly made by a TL (thermal luminescence) laboratory (**Fig. 2**). SEM-EDS analysis indicated only carbon, suggesting a glue of some sort. The other is a whitish, calcareous-like gritty film of patina-like matter. This patina-like material is visible mainly in the depressions and crevices on both sides. Patina is the natural crust that is created over the surface due to the absorption or loss of various elements. It is commonly thought that the process of patination is slow; thus, genuine patina may be seen as an indicator of the antiquity of an item. This common knowledge is recognized by many archaeologists, antique dealers, and collectors alike. While one can readily accept that genuine patina formed over an item is younger than the design, there are several difficulties in evaluating its age. In the creation of patina, two factors play a crucial role. The first is the composition of the substrate over which the patina is processed. The second is the environment—that is, the nature of the sediment, pH, temperature, and humidity that surround it.

In principle, the first coating material, whether wax or glue of some kind, does not disprove the authenticity of the bullae. That is, because we know nothing of the history of their discovery and handling prior to the time period of our analysis, the first coating material could have resulted from substandard storage, handling, or "restoration" practices of an owner or dealer in the past. However, the petrographic and SEM examinations of the patina revealed a calcitic composition. The patina is spread over the surface in a gritty manner. Calcitic patina is created in the Mediterranean subhumid climatic conditions that prevail in Judah from the precipitation of calcium carbonate in groundwater. When the temperature or composition of the ground environment is changing, the carbonate recrystalizes from the groundwater to form a calcitic coating over rocks and other surfaces. This reflects cycles of wet and dry events, often over a long elapse of time. While in theory such coating can occur over the surface of a small unfired clay object, these processes should affect also the water-absorbing unfired clay, which would cause the object to crack and crumble. Hence, the presence of calcitic patina on an unfired bulla should result a priori in its destruction. Accordingly, none of the above-mentioned unfired bullae (from Lachish or Wadi ed-Daliyeh) bears any patina. In contrast, most of the bullae from Jerusalem that we examined did have calcitic patina, but they were all found by our testing to be fired and well-sintered. Under these circumstances, the patina-like gritty calcitic material on the surfaces of Berekhyahu 1 and 2 and Gealiyahu 1 could not have been created under natural conditions on these unfired items in the Mediterranean subhumid climatic zones of Judah, including Jerusalem. The association of the gritty calcitic coating of the bullae with the glue may therefore be interpreted as an attempt to attach the powdered calcitic matter to the surface in order to replicate a patina-like process. While the contradiction between the unfired state of the clay and the presence of calcitic patina over it could not fool an expert, it could deceive a potential enthusiastic collector.

Conclusion

The two bullae of Berekhyahu son of Neriyahu the scribe are modern creations, reflecting a series of technological misconceptions, anachronisms, and technological errors. Gealiyahu 1 is identical to them, most likely from the same forger's hand. These technological misconceptions and technical errors represent the state of the research at the time when these counterfeits were revealed, sold to collectors, and published by academics. All these lines of evidence put together clearly point at modern creation. As mentioned by our colleague Christopher Rollston (in press) in another article tackling this issue, the present publication unfortunately may serve as an improved protocol for future forgers, whose work may become increasingly sophisticated. It is an unfortunate circumstance that these bogus artifacts could "star" for several decades in some of the scientific literature, in museum showcases, and in the popular literature, as emblems of Iron Age epigraphs. While many other bullae from the antiquities market that we examined, including some mentioning royal names (to be published elsewhere), were found to be authentic with great certainty, the Berekhyahu bullae raise again the problem of unprovenanced artifacts being published without any systematic and serious laboratory analysis. Of course, laboratories and archaeological scientists may be divided in their opinions, as has happened with many other biblical-era artifacts discussed recently by the media and elsewhere. But if there are serious doubts, the public should be made aware of them, and the scientific community should take extra measures to avoid the uncritical, irresponsible publication of fakes that results in the contamination of our history.

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