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ABBREVIATIONS

AASOR	Annual of the American Schools of Oriental Research
ADAJ	Annual of the Department of Antiquities of Jordan
AJA	American Journal of Archaeology
AfO	Archiv für Orientforschung
ANET	Ancient Near Eastern Texts Relating to the Old Testament[3], ed. J.B. Pritchard, Princeton, 1969
BA	The Biblical Archaeologist
BASOR	Bulletin of the American Schools of Oriental Research
BT	Babylonian Talmud
CAD	Chicago Assyrian Dictionary
CIS	Corpus Inscriptionum Semiticarum
DJD	Discoveries in the Judaean Desert
DSD	Dead Sea Discoveries
EI	Eretz-Israel: Archaeological, Historical and Geographical Studies
ESI	Excavations and Surveys in Israel
IAA Reports	Israel Antiquities Authority Reports
IEJ	Israel Exploration Journal
JAOS	Journal of the American Oriental Society
JBL	Journal of Biblical Literature
JCS	Journal of Cuneiform Studies
JEA	Journal of Egyptian Archaeology
JNES	Journal of Near Eastern Studies
KAI	W. Donner and W. Röllig: *Kanaanäische und aramäische Inschriften* 1–3, Wiesbaden, 1962–1964; 1[5], 2002
NEAEHL	The New Encyclopedia of Archaeological Excavations in the Holy Land (English Edition), Jerusalem, 1993
PEQ	Palestine Exploration Quarterly
PT	Palestinian Talmud
QDAP	Quarterly of the Department of Antiquities in Palestine
RA	Revue d'Assyriologie et d'Archéologie Orientale
RB	Revue Biblique
RE	Pauly-Wissowa's Realencyclopädie der classischen Altertumswissenschaft
RQ	Revue de Qumran
VT	Vetus Testamentum
ZA	Zeitschrift für Assyriologie
ZDPV	Zeitschrift des Deutschen Palästina-Vereins

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A Cuneiform Tablet from the Ophel in Jerusalem

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ABSTRACT: A small fragment of a Late Bronze Age letter in Akkadian was discovered in the Ophel excavations in Jerusalem. Its sign-forms suggest that it is a rough contemporary of the Amarna letters, including the letters of Abdi-Heba, the ruler of Jerusalem. The analysis of the tablet by optical mineralogy, supported by XRF spectrometry, reveals that its raw material is typical of the *Terra Rossa* soils of the Central Hill Country. It is suggested, therefore, that it was a local product of Jerusalem scribes, made of locally available soil. This, coupled with the fact that its find site is close to what must have been the acropolis of LB Jerusalem, makes it likely that the letter fragment does in fact come from a letter of a king of Jerusalem. It may well be an archival copy of a letter from Jerusalem to the Pharoah.

INTRODUCTION

A small fragment (28.254×20.522 mm.; minimum width [nice cut edge]: 8.895 mm., maximum width: 19.002 mm.) of a Late Bronze Age cuneiform clay tablet (no. 7327, Locus 240; henceforth 'Jerusalem 1'; see fig. 1 on p. 7) was discovered in the Ophel excavations, located at the Eastern Hill of Jerusalem, between the City of David and the Temple Mount. The excavations, conducted on behalf of the Hebrew University of Jerusalem and directed by Eilat Mazar, were carried out over a three-month period, between November 2009 and February 2010. Funding was provided by Daniel Mintz and Meredith Berkman (New York) for completion of the archaeological excavations and for preparation of the site for the public within the Ophel Archaeological Park and the national park around the walls of Jerusalem. The excavations followed several previous excavations in that area, the earliest of which was by Charles Warren in 1867 (Mazar and Mazar 1989).

During the excavations, the contents of loci holding special significance were sent for wet sieving to Emek Zurim, a wet-sieving facility site, directed by Dr. Gabriel Barkay and Zachi Zweig, under the auspices of the Nature and Parks Authority and the Ir David Foundation. The wet sieving of these loci increased by 95% the amount of small finds discovered at the site, including beads, amulets, ivory, figurines, bullae, scarabs, fauna (including numerous fish bones) and flora (numerous olive pits). The process of wet sieving rescued thousands of small finds, which would not otherwise have been found. The cuneiform tablet is one of these finds.

The article includes an introduction and a section on the Ophel excavations by Eilat Mazar, a study of the tablet's cuneiform text by Wayne Horowitz and Takayoshi Oshima, including historical considerations, and a provenance study by Yuval Goren.

THE OPHEL EXCAVATIONS

The Ophel excavations revealed a section of the city wall, 70 m. long and preserved 6 m. high, dated to the Iron Age IIa. Uncovered in the city wall complex are: the northern edge of Warren's Great Tower adjacent to an inner gatehouse, providing access into the Ophel area of the city; a royal structure adjacent to the gatehouse; and a corner tower overlooking a substantial section of the adjacent Kidron Valley. No architectural remains prior to the construction of the Iron Age IIa city wall complex were found in this area.

The tablet was found in area E of the excavations (area supervisor: Ariel Winderboim), in an earth fill of the great tower, which contained mainly relatively small fragments of local pottery ranging in date from the Early Bronze Age to the Iron Age IIa.

The great amount of pottery sherds found within the massive construction fill of the Great Tower was needed to reinforce its stability. Thus, it is most likely that a major part of that fill was brought from the City of David dumps, which contained many sherds from all periods of the city's existence.

Characteristically LB ceramic remains were also found in the fill of the Great Tower, as well as in the fills discovered in the City of David during excavations directed by Macalister and Duncan, by Kenyon and by Shiloh. Only scarce LB structural remains, however, were exposed in their excavations along the eastern slope of the City of David (Cahill 2003: 27–28).

E. Mazar's 2005–2008 excavations at the summit of the City of David, located less than 100 m. south of the Great Tower, yielded an earth fill that had accumulated over a long period of time — from the Middle Bronze Age II to the Iron Age I. A few sections of a packed grey earth layer were encountered in the earth accumulation, containing local LB pottery types and Cypriot imports. Among the finds was a small, nearly complete, Cypriot base-ring juglet. Like in the Ophel excavations, no architectural remains earlier than the Iron Age IIa were found during Mazar's City of David excavations, leading her to suggest that it was an open area alongside the city's main thoroughfare, just outside the northern city wall, from the Middle Bronze Age II to the Iron Age I (Mazar 2009: 26).

Future excavations to the south of this area may also reveal the remains of the LB city, including its palace fortress, mentioned by the ruler of Jerusalem whose name is most often rendered Abdi-Heba.

JERUSALEM 1: A FRAGMENT OF A LETTER FROM JERUSALEM[1]

The Jerusalem letter fragment — called 'Jerusalem 1' according to the numbering system used in the *Cuneiform in Canaan* volume (Horowitz, Oshima and Sanders 2006) — is a small fragment from the left edge of a letter in Akkadian from the Late Bronze Age. It contains no more than parts of only nine lines — five on the obverse and four on the reverse — with no line preserving more than four complete signs or parts of five signs. The fragment is too small to permit an estimate of the tablet's original height and length.[2] With so little to work with, we cannot restore even a single full phrase in its entirety with any degree of certainty. Furthermore, even the dating of the tablet is complicated by the small size of the sample of sign-forms. Nevertheless, we believe that we can confirm, on epigraphic grounds, the Late Bronze Age date suggested by the archaeological context of the fragment and that we can provide an historical context that would be consistent with a local origin for the fragment (as identified by the optical mineralogy analysis; see below).

EDITION AND TRANSLATION (figs. 1–2)

Basics: Clay tablet; 22×18×10 mm.
Reg. No.: 7327
Date: Late Bronze Age
Language: Akkadian
Find Information: See above

Obverse	Translation[3]
1' [x (x)] x x [. .	*traces*
2' ⌜*tab-ša*⌝ *am-m*[*u-* …	*You were* . . […
3' *iš*-DUM *a-na a*[*l*ʾ- …	*a foundation*/*after* for . […
4' *i-pé-ša* x […	to do . […
5' x x […	*traces*

Reverse	Translation
1' *traces or vacat with scratches*	
2' ZI BI x […	… […
3' *šu-nu* […	they […
4' [*n*]*u*-[…	. […

1 The authors of this section, W. Horowitz and T. Oshima, wish to thank Joachim Marzahn (The Vorderasiatisches Museum) for facilitating our study of the Abdi-Heba letters in the museum's collections. We also thank Shlomo Izreʾel and Michael Streck for constructive criticism offered in the preparation of this portion of the article. All

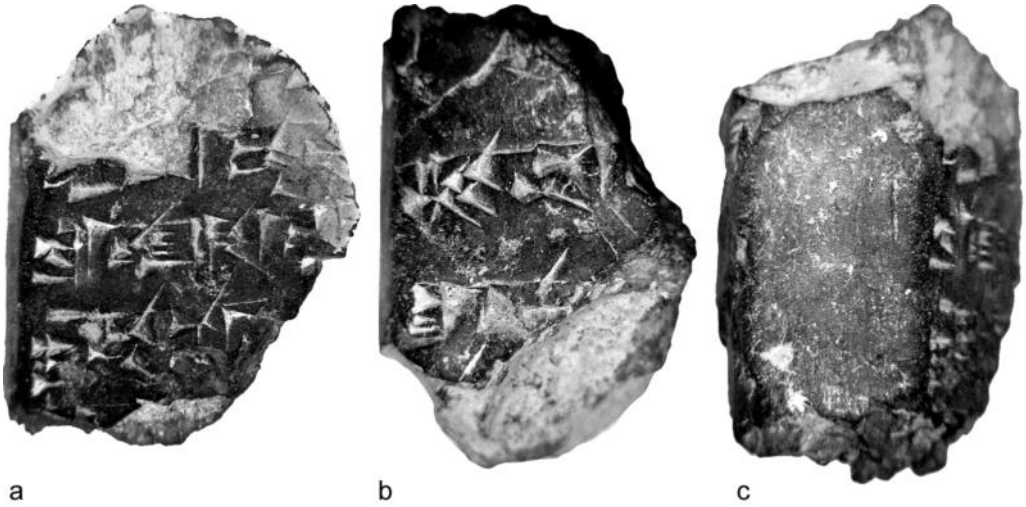


Fig. 1. Ophel tablet: a) obverse; b) reverse; c) tablet's surviving left edge obverse (photos by Mimi Lavi, Head of the Conservation Laboratory of the Institute of Archaeology of the Hebrew University of Jerusalem)

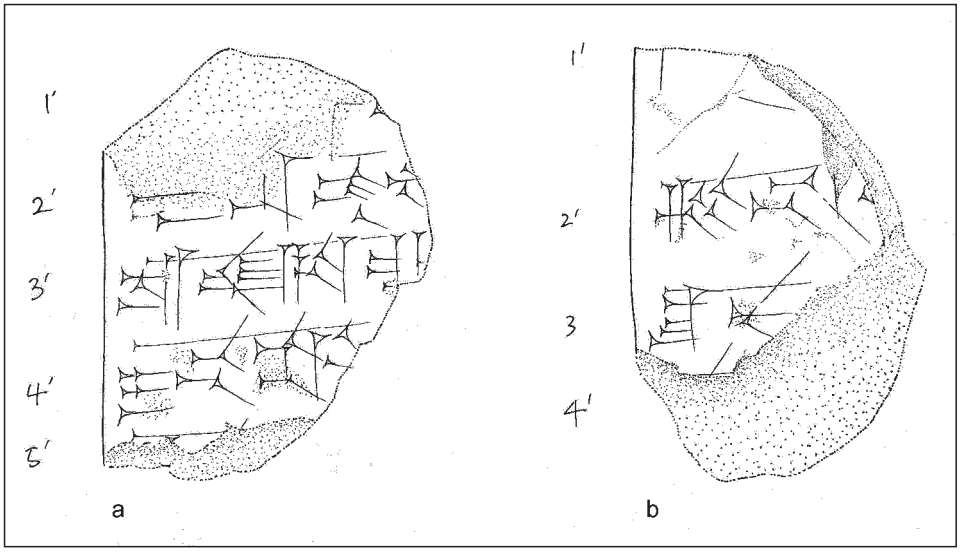


Fig. 2. Ophel tablet: hand copies; a) obverse; b) reverse

errors of commission and omission in this section are solely the responsibility of Horowitz and Oshima.

2 For some observations concerning the size and shape of the tablet, see below.

3 Italics indicate uncertainty in the translation.

NOTES

Obverse

Line 2′. — The signs and traces fit a second person form from *bašû*, 'to be', with the next word being for a form of the pronoun *ammu*, 'that', which occurs at Amarna (Knudtzon 1915: 1372). Other interpretations are invited. For the form of ŠA, see commentary to line 4', below.

Line 3′. — The word *iš*-DUM could be for the noun *išdum* or for *ištu*(*m*) — which may serve as either a preposition or a conjunction – here with a reading *iš-tum* with mimmation, or *iš-tu*$_4$ without mimmation.[4] The noun *išdum* has the basic meaning of 'foundation, base', with extended meanings such as 'tree trunk', 'administrative or political (re)organisation (of a country or city)' and 'discipline of an army'.[5] In the Amarna letters, this word is only attested in the context of the bases of items of jewellery, all in inventories of gifts, and all examples with possessive suffixes.[6] Thus, the Amarna examples do not seem relevant to the Jerusalem piece, where the word ends with the nominative suffix *-um*. If it is *ištu*(*m*), we must have here the word serving as a conjunction, as is attested several times in Amarna.[7] A double preposition *ištu*(*m*) *ana* would be unprecedented in Akkadian.

Line 4′. — The form of ŠA is a little bit sparse when compared with the forms given in the table of Amarna sign-forms in Schroeder 1915b: 87 and in table 1 below, all of which begin with at least three horizontals. It is possible that one or two small, slightly indented, shallow horizontal strokes were present at one time between the two surviving deeply incised horizontals that open the sign, but that these have become effaced. On the other hand, the forms of ŠA in Taanach 2:19' and 21' are even sparser than our Jerusalem form.

Reverse

Line 2′. — In the handwriting of many scribes from our period, ZI and GI may be confused for one another. The form here seems to us to be for ZI, but without context GI cannot be totally excluded.

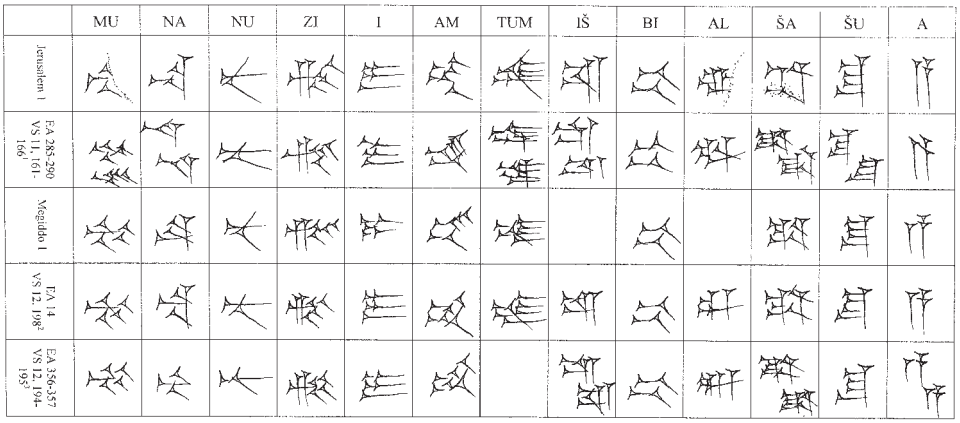
HISTORICAL CONSIDERATIONS

The sign-forms of Jerusalem 1 fit the time frame of the Late Bronze Age and as such, identify the Jerusalem letter fragment as a rough contemporary of the

4 Two examples of this writing are found in Amarna letters *EA* 211:16 and *EA* 250:54.
5 See *CAD* I/J 235–240.
6 *EA* 20:81, 22 i 24, ii 45, 25 ii 60, iv 29. See Knudtzon 1915: 1428.
7 See Knudtzon 1915: 1430. The line could then be of the type: *ištu ana* PN/GN … followed by a verb in the subjunctive, 'After you spoke/went/did … to/with PN/GN'. For *ištu*, see also Rainey 1996: II, 35–37.

Amarna letters,[8] including the letters *EA* 285–290 of Abdi-Heba,[9] as well as examples of Late Bronze letters from the *Cuneiform in Canaan* corpus itself (see table 1). These include the Taanach Letters (Taanach 1–2, 5–6 and the fragments Taanach 8, 8a, 9–11), the Governor's Letter from Aphek (Aphek 7), the letters Tell el-Ḥesi 1 and Hazor 10, and the cylinder letter Beth Shean 2.[10]

Table 1



1 Letters from Abdi-Heba of Jerusalem. 2 A list of gifts of Amenophis IV to Burnaruaš.
3 VS 12 194 is Adapa and the Southwind and 195 is Nergal and Ereškigal.

Although this allows us to narrow down the place, time frame and cultural context of the new Jerusalem fragment to the cuneiform west of the Late Bronze Age, it does not address the more specific question as to whether the fragment can be identified with the letters of Abdi-Heba of Jerusalem, recovered at Amarna. It is this question that will concern us next.

8 For an overview of the Amarna letters, with translations, notes and bibliography, see Moran 1992. The most recent full edition of the Amarna letters remains Knudtzon 1915. A new edition, with new copies, photographs, and both transliterations and translations, is long overdue.

9 *EA* 285–290 (copies VS 11 161–166), see Moran 1992: 325–334, with the corresponding tablet numbers in the Vorderasiatisches Museum given both in Moran and VS 11 = Schroeder 1915a. The very fragmentary *EA* 291 (VS 11 167) is also identified in the modern tradition of Amarna studies as a letter from Jerusalem (see, e.g., Moran 1992: 334). However, note that Goren, Finkelstein and Naʾaman (2004: 269) give the origin of the tablet's clay as being typical of the Gezer tablets; consequently, the identification with Jerusalem is not totally secure. For the reading of the name Abdi-Heba, see, e.g., Moran 1992: 379, but note Hess 1993: 176–177, who reads ÌR-*he-ba* in his section for Names with 'Logograms of Uncertain Interpretation'.

10 For an overview of the Late Bronze Age tablets from Canaan, see Horowitz, Oshima and Sanders 2006: 15–19.

In general, one may categorize the ductus of the tablets from the Late Bronze Age cuneiform west, including both Amarna and Canaan, as basically Babylonian, but with a number of local western idiosyncrasies. A good example in point is the A-sign, which in all almost all periods and genres of cuneiform writing consists of a single long vertical stroke, followed by two short vertical strokes ( ). At Amarna and in the Late Bronze Age West, a variant of this sign is often used ( ). This consists of the same basic strokes (the three verticals), but with the strokes arranged very differently, forming a kind of two pronged/spire fork shape. There are also alternate Amarna/Western forms of NA ( ), KA ( ), TI ( ), and, of course, other signs. The distribution of these alternate Amarna/Western forms and other even smaller variations in handwriting gives the impression that a wide spectrum of individual hands existed in the cuneiform west of the Late Bronze Age, ranging — from a Babylonian point of view — from a good 'high' script, which reproduced the sign-forms of the Babylonia homeland, to a 'lower' local western hand, consisting of a mixture of Babylonian, quasi-Babylonian and local forms. In terms of Amarna and the *Cuneiform in Canaan* corpus, 'high' can be defined as the ductus of tablets such as the letter from Pharoah to Burnaburiash, King of Babylon, *EA* 14, as well as the literary tablets Megiddo 1 (the Megiddo example of *The Gilgamesh Epic*), the Amarna versions of *Nergal and Ereškigal* (*EA* 357 = VS 12 195) and *The Adapa Epic* (*EA* 356 = VS 12 194).[11] In contrast, 'low' includes the hand of most of the Late Bronze *Cuneiform in Canaan* corpus, including the aforementioned letters and letter fragments.

For the sake of our comparison of the sign-forms on the letters of Abdi-Heba with those on the new Jerusalem fragment, we made use of the best currently available database of forms from Amarna and the cuneiform west (the list at the end of Schroeder 1915b = VS 12),[12] supplementing this older study with our own review of the tablets of Abdi-Heba from photographs, and on the basis of collations which we performed during a visit to the Vorderasiatisches Museum in April 2010. Our impression is that the tablets of Abdi-Heba may be characterised as 'higher' rather than 'lower', in that they most often make use of standard Babylonian forms, for example the Babylonian A, NA and KA forms (see above), although some signs, notably TI, LUGAL and KI, may be classified as belonging to the 'lower' western type. Within these parameters, some variation may be noted, suggesting that the available Abdi-Heba letters were not all necessarily written by the same scribe.

11 For *Adapa*, see also the edition of Izreʾel 2001, where the author's discussion of the ductus of *EA* 356 on pp. 51–54 (which Izreʾel identifies as being the same as that of *EA* 357) seems to be moving in the direction of identifying a 'high' script at Amarna.

12 These tables are based on Schroeder's own hand copies of the Amarna tablets in the Vorderasiatisches Museum (published in Schroeder 1915a and 1915b = VS 11–12). Here, Schroeder divides the sign-forms into ten groups on the basis of the provenance of the senders: 1) Mitanni; 2) Hatti; 3) Alašia; 4) Ägypten; 5) Babylonian; 6) Gebal; 7) Beirut, Sidon, Tyrus; 8) Jerusalem; 9) Amurru; and 10) other forms.

We then compared the sign-forms of the Abdi-Heba letters with those on the Jerusalem fragment. Many forms on the Jerusalem fragment match those of the Abdi-Heba letters (MU, NA, ZI, I, BI, ŠU and A), but some do not (NU, AM, TUM, IŠ, AL and most likely ŠA, although this sign is not completely preserved on Jerusalem 1).[13] More generally, the hand of Jerusalem 1, like the hand of the Abdi-Heba letters, can be categorized as 'higher' rather than 'lower'. In particular, the Jerusalem fragment's A-sign, and especially NA, are very Babylonian (see table 2), while its other signs could be equally at home in second-millennium Babylonia as in Amarna and Canaan.[14] Little or nothing on Jerusalem 1 betrays the fact that our fragment is from the west. All this, again, places the ductus of Jerualem 1 much nearer the 'high' end of the spectrum than the 'low' end. Yet the differences between Jerusalem 1 and *EA* 285–290 do not allow us to identify the scribe of Jerusalem 1 with the scribe (or, more likely, scribes) of the Abdi-Heba letters. In fact, it is our impression that the scribe of Jerusalem 1 shows greater expertise than the scribes of Abdi-Heba in *EA* 285–290.

Table 2

	Jerusalem 1	Aphek 7	Gezer 2	Hazor 10	Tell el-Ḥesi 1	Shechem 2	Taanach 1	Amarna	Babylonia
A	3'	1, 7	12'	1, 8, 14	11, 15		5, 9, 10		
IA			3', 10'	8, 9	11	r. 3	9		
NA	3'	1, 7, 8	6'	1 8	15	r. 3	1, 9 10		

Our conclusion, then, is that the scribe of the Jerusalem fragment seems capable of producing high-quality international-standard scribal work, a conclusion that is also supported by the shape of the fragment, as indicated by the surviving piece of the left edge, which seems to us to be closer to the Mesopotamian ideal than most tablets from the cuneiform west.[15] Thus, given the fact that the tablet is written on clay from the Jerusalem region (see below) and that its find site is close to what

13 For ŠA, see commentary to obverse line 4', above.

14 For the Babylonian sign-forms we made use of Labat 1976 and Borger 1981, as well as Fossey 1926.

15 In terms of the Abdi-Heba letters, the edge of Jerusalem 1 seems similar to the edges of *EA* 286–288 (VS 11 162–164), in particular *EA* 287. *EA* 286–288 are all long rectangular tablets, each with more than 60 lines of text, and all three are made of local clay (Goren, Finkelstein and Naʾaman 2004: 266–267). Based on this, one might surmise that Jerusalem 1 was rectangular and long as well. The tablets for the other Abdi-Heba letters are much shorter and less well executed.

must have been the acropolis of Late Bronze Age Jerusalem, there is good reason to believe that the letter fragment does, in fact, come from a letter of a king of Jerusalem, most likely an archive copy of a letter from Jerusalem to Pharoah. If so, the fact that an archive copy was retained would be evidence of the importance of the original Jerusalem letter.[16] Could the Jerusalem king in question be Abdi-Heba? Perhaps, but again perhaps not, since Jerusalem 1 does not include any specific feature that would tie it directly to *EA* 285–290. In short, the ductus of our letter fragment would be appropriate for a finely written letter from a king of Jerusalem to the Egyptian court.

THE LETTER CONTENTS

The contents of the letter fragment provide no parallel to the surviving letters of Abdi-Heba, and it is too small to permit us even a guess at the message it was intended to convey. In obverse line 4', there may be a clear indication of Amarna-type phraseology, which one would expect in a royal letter of the Late Bronze Age. Here one finds *i-pé-ša*, which appears to be a writing for the infinitive of *epēšu*, 'to do', also attested in Hazor 10:19, perhaps from the Lebanon,[17] and in *EA* 79:24 and 129:27 in letters from Rib-Hadda of Gubla (Byblos).[18] Thus, this phrase, and consequently the tablet's scribe, just might be from what is now northern Israel or Lebanon. However, three scattered examples do not a rule make.

Given the above, it is clear that we know next to nothing about the original contents and circumstances of the letter. The main significance of this new find does not lie in what we can learn by reading the tablet, but in the historical and archaeological context of the tablet itself. Jerusalem 1 provides the first direct evidence for the use of cuneiform in Jerusalem — previously known only indirectly, from the letters of the Amarna-period king of Jerusalem, Abdi-Heba. Thus, this fragment now allows us to add Jerusalem to the list of cities, including its neighbours Shechem to the north, Hebron to the south, Jericho to the east and Gezer to the west, which have yielded Late Bronze Age cuneiform finds.

PROVENANCE STUDY

Cuneiform archives from the Ancient Near East (ANE) contain abundant tablets of unknown origin. Although tablets might be assigned an origin on the basis of

16 See the discussion in Moran 1992: xvii.

17 See Goren, Finkelstein and Naʾaman 2004: 230 (the letter Hazor 10 = IAA 1997–3307, incorrectly listed there as an economic document).

18 For further examples of the infinitive with slightly different writings, see Knudtzon 1915: 1403. Also possible, although very unlikely, is that *i-pé-ša* could be a writing for the 3rd feminine plural of the same verb, *ippešā*.

their style or location, this may remain a matter of dispute. Hence, revealing the origin of documents has the potential of shedding new light on the geographical history, the development and transfer of syllabic information, the diffusion of language and literature, scribal habits, narratives and epics within the ANE and beyond. In practice, this goal can be accomplished through provenance studies of the clay of documents and archives from different parts of the ANE. The use of methods adapted from natural and exact sciences provides independent data regarding the tablets' origins that may corroborate or refute hypotheses based on the data extracted from the texts. Following two pioneering, albeit rather limited, studies (Artzy, Perlman and Asaro 1976; Dobel, Asaro and Michel 1977), most of the tablets from the Amarna archive were studied by Goren *et al*. (Goren, Finkelstein and Naʾaman 2002; 2003; 2004; Goren, Bunimovitz, Finkelstein and Naʾaman 2003). A collection of syllabic, legal, administrative and scholarly texts from the archives of Ugarit (Ras Shamra), along with a few letters, were studied by Goren, in collaboration with Y. Cohen and M. Kaufman (Kaufman 2008). Eighty documents from the archives at Hattuša (present-day Boğazköy, Turkey), the capital of the Hittite Empire in the Late Bronze Age, were studied by Goren and H. Mommsen in the Vorderasiatisches Museum in Berlin (as yet unpublished). The Cypro-Minoan texts from Enkomi and Kalavasos, Cyprus, were studied by Goren *et al*. (Goren *et al.* 2003; Goren, Finkelstein and Naʾaman 2004) as part of the Amarna project. Southern Levantine tablets and other texts on clay were also analysed (Goren, Finkelstein and Naʾaman 2004; Goren *et al.* 2007; Goren *et al.* 2009; Naʾaman and Goren 2009).

The scientific analyses of these clay-derived documents focused on their mineralogical and elemental compositions, with the aim of identifying their provenance and technology. This was based mainly on optical mineralogy (OM, commonly misnamed as petrography),[19] supported in specific cases by instrumental neutron activation analysis (INAA) for measuring the elemental concentrations of the clay. This has enabled the compilation of a considerable database, including the analytical data of hundreds of cuneiform tablets from some major archives.

At the same time it became clear that new methods should be introduced, in order to enable non-destructive, scientifically based, *in situ* provenance studies of cuneiform tablets in museums, departments of antiquities and other collections. For this task, Y. Goren has recently introduced the handheld X-Ray Fluorescence (XRF) spectrometer.[20] This enables the task to be carried out with

19 The term 'petrography' refers to the study and composition of rocks. Therefore, the term 'optical mineralogy' should be preferred for the method used here.

20 XRF is the emission of characteristic secondary energy from the atoms of a material that has been irradiated with high-energy X-rays. These secondary rays are captured by a detector and measured, in an effort to supply qualitative and quantitative values

great efficiency, albeit with some limitations, which will be discussed in brief below.[21]

In order to achieve this goal, some 100 tablets, previously examined by OM and in great part by INAA as well, were examined by handheld XRF; the results were used to establish the grouping of the tablets according to the concentrations of selected significant elements present. The examined tablets included royal letters from Babylonia, Mitanni, Hatti, Alašiya, Arzawa and Egypt. These groups were compared with the previous results, retrieved by OM and INAA, in order to substantiate their validity. The clusters established by this method were based on 12 significant elements. The composition of the Jerusalem 1 tablet, as measured by XRF, was compared statistically with this database.[22]

The analysis of Jerusalem 1 was conducted by OM and XRF. The principles of OM analysis of cuneiform tablets have been described in detail elsewhere (Goren, Finkelstein and Naʾaman 2004: 4–22). Under the stereomicroscope, minute samples were extracted from the tablet by the peeling technique[23] and examined in thin sections under the petrographic microscope.

The scanning of the database tablets, as well as of Jerusalem 1, was carried out by a portable XRF equipped with a silicon drift detector (SDD), having low limits of detection (LOD) values.[24] Since the geometry of the sample can cause differing

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of the elements in the matter. The past few years have seen a meteoric and practical development of handheld and portable XRF units, increasing the speed and efficiency of the testing process and making it available outside the research laboratory. In archaeology, the use of a handheld XRF enables *in situ* elemental analysis of an object without extracting samples from it.

21 The method will be discussed more fully in a forthcoming publication (in preparation).

22 The database used for this study was compiled as part of a research project titled 'An Interdisciplinary Approach to the Study of the Hittite Archives from from Boğazköy/Hattuša and Other Sites', conducted by Goren and J. Klinger from the Freie Universität Berlin. The author (Y. Goren) gratefully acknowledges funding for this project from the German-Israeli Fund (GIF, contract no. 1016-272.4/2008).

23 In this method, shallow laminae, measuring only a few millimetres, are peeled off from a broken facet of the tablet with the aid of a scalpel or a botanical needle. The samples are set in small moulds and dried in an oven at 60° C for a few hours. Then the cups with the samples are put in a desiccator, where the samples are impregnated with low viscosity epoxy resin under vacuum conditions. After curing, the resulting pellet is used for the preparation of a standard thin-section and subjected to routine petrologic examination under a polarising microscope.

24 The handheld XRF in use was a Thermo Scientific Niton XLt-900 GOLDD, having a 50 kV X-ray tube with a Geometrically Optimized Large Area Drift Detector (GOLDD), 80 MHz real-time digital signal processing, and dual embedded processors for computation and data storage. The irradiation area is circular, 8 mm. in diameter, making it efficient for relatively non-homogeneous surfaces such as earthenware. The Niton XLt-900 GOLDD is capable of detecting up to 32 elements (by the mining

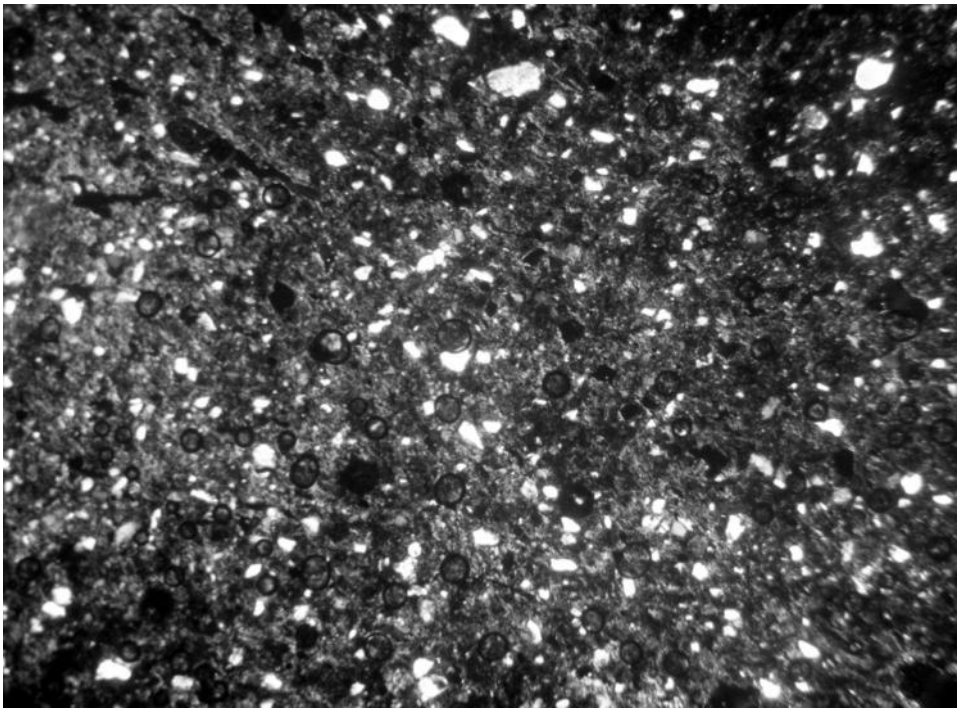

Fig. 3. The clay of Jerusalem 1 in thin section under the petrographic microscope, crossed polarizers, field length: *c*. 2.5 mm.; the matrix is *Terra Rossa* soil with quartz silt (bright bodies) and no temper

results, three different flat and smooth surfaces (existing on almost every cuneiform tablet) were measured, and the results were averaged.[25] Although this method cannot yet replace INAA as a general elemental provenancing procedure for ceramics, it can become sufficiently powerful in cases where internal groupings of 'closed' populations of delicate items are needed (Morgenstein and Redmount 2005). The database used for the analysis of Jerusalem 1 was compiled by establishing the 'XRF grouping' of local tablets (as determined by OM and INAA) from Hattuša, Ugarit, Alašiya, Waššukanni (the capital of Mitanni), Carchemish, Babylonia, Egypt (local texts from el-Amarna and the letters sent to Hattuša from the court of Ramses II), and several other landmarks.

Under the petrographic microscope, OM analysis reveals that the raw material of the tablet is readily identified as *Terra Rossa* soil (fig. 3).[26] *Terra Rossa* soils

matrix), using four different filters (main, low, high and light) for the detection of the entire range from Mg down to U.

25 This procedure has become standard practice in the mining and natural resources industry, after tests have indicated that the portable XRF instrument can give excellent correlation with laboratory-based reference methods, such as atomic absorption spectrometry (Radu and Diamond 2009).

26 In thin section, it appears as a fabric with a reddish-tan to dark matrix, highly optically active under crossed polarizers, with nearly 20% silt. The silt is mainly quartzitic but also contains some accessory heavy minerals, of which hornblende and zircon are the most common, along with a few plagioclase feldspars. The inclusions are of very fine limestone sand.

occur on hard limestone and dolomite exposures in the semi-arid to sub-humid Mediterranean climatic zones. This soil material is eroded downslope, forming colluvial-alluvial soils. The composition of the silt in Jerusalem 1 is typical of *Terra Rossa* soils of the Central Hill Country of Israel.[27] As opposed to the silt of the Nile sediments in Egypt or the Aegean 'Red Clays' (namely alluvial deposits derived from *Terra Rossa* soils), the silt of southern Levantine *Terra Rossa* soils is poor in accessory components such as mica minerals, pyroxenes and amphiboles, because these relatively heavy and unstable minerals (in comparison to quartz) are lost in the process of aeolian transportation and deposition.

The elemental concentrations of Jerusalem 1, as measured by XRF, are presented in table 3. The data was compared with the elemental concentrations of the data sets of some 100 tablets, including international letters from the main ANE superpowers. These were measured in the Vorderasiatisches Museum in Berlin, using the statistical procedure developed in Bonn including considerations

Table 3. Elemental composition of Jerusalem 1
(major elements are in weight %, minor elements in PPM)

Element	Value	Error (2 Sigma)	Element	Value	Error (2 Sigma)
Balance	53.38%	2.11%	Cu	314.97	13.42
Si	27.25%	0.21%	Zr	314.62	3.73
Al	6.78%	0.46%	V	230.71	25.93
Fe	5.38%	0.03%	Zn	186.19	8.73
Ca	3.55%	0.03%	Cr	167.98	23.83
K	2.21%	0.03%	Sr	73.73	1.73
Ti	5350.92	58.48	Ag	63.21	15.75
P	5099.91	525.23	Ni	59.22	18.94
S	740.97	155.83	Nb	27.89	1.53
Mn	683.65	44.73	Rb	24.49	1.00
Ba	520.78	43.72	As	11.28	2.03
Cl	432.46	33.23	As	11.28	2.03

27 All the soil materials in Israel include, to varying extents, aeolian dust of desert origin. Carbonate rocks do not contain silt-size quartz grains, but large quantities of such grains occur in the soils that developed on these rocks. The external source of the silt-size quartz grains is considered to be an aeolian contribution to the soil. The largest amount of aeolian dust occurs in soils that developed on hard limestone and dolomitic limestone, in which the residual material released from the dissolution of the rocks is only about 2% (Adan-Bayewitz and Wieder 1992).

of experimental uncertainties and possible 'dilutions'.[28] The multivariate statistical tests were made, using a SAS-JMP 8 statistical package. These included cluster analysis (Ward's method), discriminant, factor and principal component analysis (PCA). The PCA plot of the data sets and Jerusalem 1 (fig. 4) indicates that Jerusalem 1 stands as a loner and is remote from the clusters of the Babylonian, Mitannian, Egyptian, Alašian, Ugaritic and Hittite documents. Therefore, it is unlikely that Jerusalem 1 was sent from any of these locations.

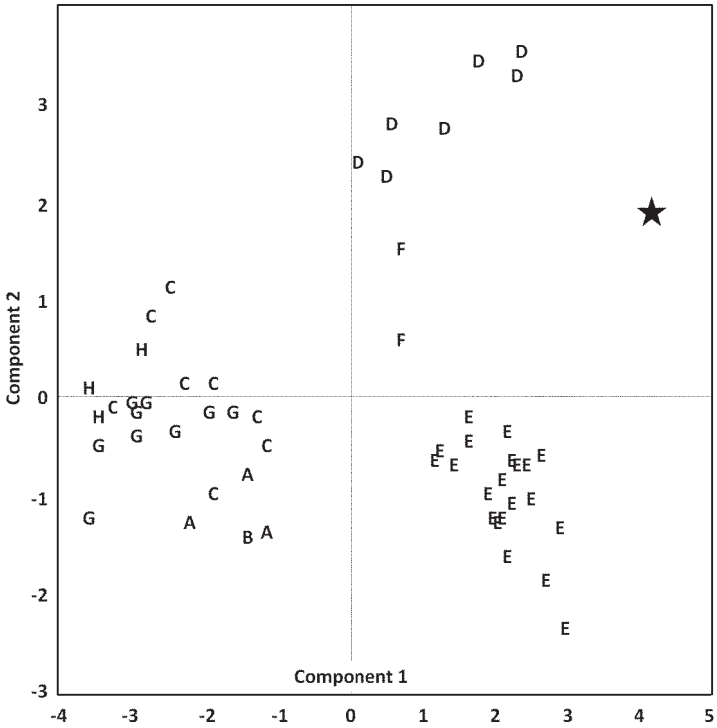

Fig. 4. PCA of the XRF results of Jerusalem 1 and the data set of ANE documents; A = Alašiya; B = Arzawa; C = Babylonia; D = Egypt; E = Hattuša; F = Karum Hattuš; G = Mitanni; H = Ugarit; * = Jerusalem 1

28 In the initial stage, the three measurements taken from each tablet were compiled on a spreadsheet and averaged, including the standard deviation and a best relative fit for each tablet. Then the exponential uncertainties were checked. Elements with errors < 20% included: Ba (12%), Cr (12.9%), Fe (4.1%), Nb (8.3%), Ni (18.5%), Rb (4.4%), Sr (9.6%), Ti (6.3%), K (9.0%), Si (8.3%), V (11.3%), Zr (4.7%) and Al (13.2%). Statistical grouping using 16 elements for best relative (dilution) included: Ca, Cr, Fe, Nb, Ni, Rb, Sr, Ti, Ag, Cu, K, V, Zn, Zr, Al and Mn. Elements known to be effected by post-depositional processes or exposing unsystematic fluctuations (i.e., Ca, As, Cu) were cleared, and the statistical tests were conducted using 12 elements: Nb, Zr, Sr, Rb, Zn, Fe, Cr, V, Ti, K, Al and Si.

The results of the OM analysis indicate that the origin of Jerusalem 1 should be sought in the Central Hill Country of Israel. Although *Terra Rossa* soils are quite widespread in the Judaean anticline, the discovery of this tablet in Jerusalem, the only major city-state of this period south of Shechem, suggests that it is a local product of the Jerusalem scribes. Indeed, its composition is identical to the fabric of the numerous local pillar figurines from the City of David (Goren, Kletter and Kamaiski 1996), the Iron Age bullae from the City of David (Arie, Goren and Samet, in press), and the Roman-period stoves from the Jewish Quarter (Goren 2010). It may be concluded, therefore, that Jerusalem 1 was made of the locally available soil at the immediate surroundings of the site.

The OM study of six letters of Abdi-Heba, the ruler of Jerusalem (Urushalim), in the Amarna archive, revealed that five of them belong to a petrographic group that is derived from the Moza and ʿAmminadav formations distributed in the Judaean anticline and frequently used for pottery production in the vicinity of Jerusalem (Goren, Finkelstein and Naʾaman 2004: 265–269). *EA* 285 is alien to Jerusalem and was most likely sent from Beth Shean. Theoretically, this may present a problem. However, the study of the Amarna letters from many Canaanite cities reveals that the clay types used by their scribes were not always consistent. Moreover, since the nearest exposure of the Moza formation is found only a few kilometres away from the assumed location of the Canaanite city, it may be suggested that while letters sent from the city were usually written on tablets made of this fine clay, some texts could have been written on the more locally available *Terra Rossa* soil.

Further support for this hypothesis may be found in the analysis of the cuneiform tablets from the 'Governor's Residence' in Tel Aphek (Goren *et al*. 2007; Naʾaman and Goren 2009). Petrographic analysis of the 'Ugaritic letter' found at the site reveals that this tablet was obviously made at Aphek and was never fired. Thus, it is either a copy of an original Ugaritic letter deposited in another place, or a literary composition that imitates authentic Ugaritic letters. Such model letters, intended to teach young scribes and to serve for future correspondence, are known from Egypt, in particular from the Ramesside period of the 19th–20th Dynasties (Caminos 1954; 1982: 243–244 with earlier literature). Recently, Naʾaman (2002: 80–81) has suggested that some letters discovered in the Amarna archive served as a teaching model. However, there may be other possible interpretations for Jerusalem 1.

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