2019 IMEKO TC-4 International Conference on
Metrology for Archaeology and Cultural Heritage
Florence, Italy, December4-6, 2019

Conservation Science and Ethics in the Analytical Studies of Clay Cuneiform Tablets from Ancient Near Eastern Archives

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Abstract *– The Late Bronze Age (ca. 1500-1200 BC) constitutes the heyday of the great empires of the ancient Near East (ANE), such as Egypt, Hatti, Mitanni, Babylonia, and Assyria. Centuries of conflicts followed by peaceful relations, marked the interrelations of these superpowers. Rich literary records in the form of archives of cuneiform texts were established. These archives contain abundant tablets whose origin is unknown. Sometimes the letterhead is missing, in other cases, we may have the name of the sender and still ignore his domicile. Further, the location of many ANE countries and cities has not yet been clearly established. Hence, revealing the origin of documents has the potential of shedding new light on the history of the ANE and beyond. The paper will discuss the use of a rich array of non-destructive testing (NDT) and minimally-destructive testing (MDT) methods for studying the composition, technology and provenance of ANE cuneiform tablets. This approach opens new horizons in the interpretation of the clay documents. We applied such analyses on hundreds of tablets from el Amarna, Ras Shamra/Ugarit, Boğazköy/Hattusha, and sites in Cyprus and Israel/Palestine. The research project made during the last decade, serves as the basis for this study. The results raise a set of ethical and practical issues concerning the study and conservation of such precious artifacts.*

I. INTRODUCTION

The era between the 3rd and the end of the 1st millennia BCE constitutes the heyday of the great empires of the Ancient Near East (ANE). This time span witnessed the production and dissemination of a large body of textual materials written upon clay tablets by means of the cuneiform script in several languages (Akkadian, Sumerian, Hittite, Hurrian and Northwest/West Semitic dialects). While some of these textual materials dealt with matters of state, administration, religious life or economy, a significant part was aimed at achieving proficiency, first in the very writing and reading of the cuneiform script, and secondly, in the knowledge of magic, medicine and the art of divination. This immense body of textual materials became widespread from Mesopotamia to be received in places far and wide—from Susa in Iran to Ugarit on the Syrian coast, and in culturally diverse centers, such as Hittite Anatolia or Pharaonic Egypt. These cultural interactions acted, throughout long and complex transmission processes, as agents of intercultural interactions. Hence, the "Cuneiform Culture" as it is often referred to, can be seen as the only source at hand of the wisdom, literacy and intellectual creation of the cradle of civilization.

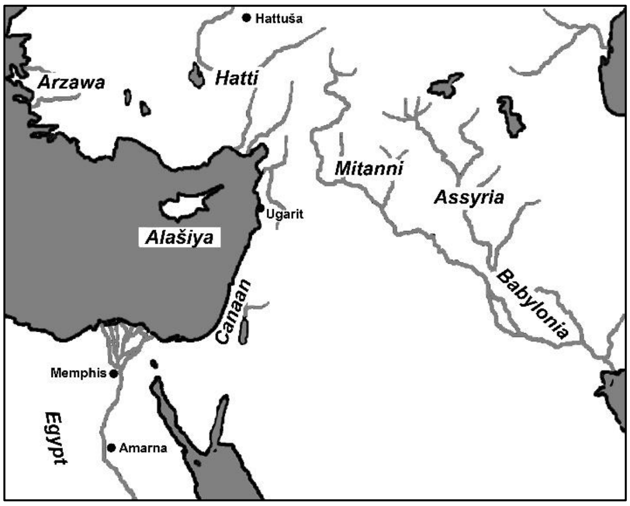

Figure 1: Map of the ancient Near East during the 2nd millennium BC with sites mentioned in the text

Archives of cuneiform texts contain numerous tablets whose origin is unknown. Letters often contain the name of the sender, but sometimes the letterhead is partly or entirely missing; in other cases, we may have the name of the sender and still ignore his domicile. Worst of all, the location of some ANE countries and towns have not yet been clearly established. Moreover, documents other than letters might be assigned to an origin only by their style or location of discovery, but this may still remain a matter of dispute. In such cases, scholars can only hope to find some paleographical, linguistic or thematical clues for the origin of a document. Despite a growing range of studies investigating the operation mode of ANE scribal schools, such as the modes of transmission of schooling and scholarly materials from Mespoptamia to other locations, there still remains a substantial gap in our knowledge of the actual production and dissemination of cuneiform materials in Anatolia, Syria and the Levant, and Egypt.

II. THE METHODOLOGICAL BASIS FOR THE PROJECT

Over the last 25 years, these issues have been tackled through the material analyses of the tablets. In the course of several research projects, the first author conducted in collaboration with other colleagues several studies that approached the problem of locating the provenance of numerous cuneiform tablets through mineralogical and chemical analyses of their clay. Documents from el Amarna, Ras Shamra/Ugarit, Boğazköy/Ḫattuša, and sites in Cyprus and Israel/Palestine were analyzed with the aim of pin-pointing their geographic origin and possible source of composition (Goren 2000; Goren et al. 2002; 2003; 2004: 76-87; 2007; 2009; 2011). By the petrographic study of the Amarna tablets it was possible to determine the location of many ancient toponyms, consequently suggesting an over-all reconstruction of the territorial and political map of Syria, the Lebanon coast and, in particular, the southern Levant. The sequel of this study saw the analysis of additional southern Levantine tablets. This was followed-up by the systematic study of documents from the rich Boğazköy-Ḫattuša archives that include official correspondence and state administration, as well as legal codes, procedures for cult ceremony, oracular prophecies and literature. In this latest study, new methodologies that involve non-destructive testing (NDT) methods were also introduced (Goren et al. 2011).

During the last years, new methods tackling other oriented research questions were introduced. Together with their advent new methodological and ethical issues arise, requiring some special attention.

III. CONVENTIONAL METHODS

Mineralogical and elemental techniques were employed in all cases. While the former identified the minerals in the clay and temper of the tablet, the latter used diverse analytical techniques to measure the concentrations of the elements in the clay (for the principles of these methods see Goren et al. 2004: 4-22, 2007, 2011; Mommsen 2004). These studies have also shown two methodological rules: first, that cuneiform tablets were not always produced of the same clay types as the local pottery; hence they should be treated separately from other archaeological ceramics. Secondly, while pottery can be often studied by the routine mineralogical and chemical methods involving intrusive sampling, clay tablets are unique and sampling, if allowed, should be much below the standards of the regular petrographic and elemental examination procedures. Therefore, together with the application of MDT sampling techniques (Goren et al. 2004: 4-12), the main effort was directed to the development of new methodologies, with the support of NDT apparatus.

Figure 2: Sampling a tablet from Emar in the Bible Lands Museum, Jerusalem, using MDT method

The use of portable X-Ray Fluorescence (pXRF) was tested to test its potential for routine provenance determination of clay cuneiform tablets, which cannot be analyzed by “classical” intrusive methods. A group of tablets from Boğazköy/Ḫattuša and from el Amarna, previously provenanced by petrography and instrumental neutron activation analysis (INAA), was analyzed by pXRF with the results used to establish the grouping according to their elemental concentrations (Goren et al. 2011). These groups were compared with the previous data retrieved by petrography and INAA in order to confirm their validity. The results corroborate the potential of the pXRF for nondestructive study of well-defined, ‘closed’ assemblages of clay-derived artifacts such as cuneiform tablets, bullae, and fine-ware pottery. Still, it should be emphasized that the method cannot substitute INAA as a general elemental provenancing procedure for ceramics, or petrography as a mineralogical tool also capable of exploring technological processes. It can become useful in cases where internal groupings of “closed” populations of delicate items are needed. Namely, measurements by pXRF of the element concentrations of tablets whose provenance has been already determined by petrography and/or INAA, can create a database for further pXRF examination of unstudied tablets from the same archives in collections where intrusive sampling is not allowed (Goren et al. 2011).

Figure 3: pXRF examination of clay cuneiform tablets from Babylon at the Vorderasiatisches Museum, Berlin in 2011.

IV. CURRENT METHODS

A. Thermogravimetric analyses

Thermogravimetric Analysis (TGA) measures weight changes in a material as a function of temperature (or time) under a controlled atmosphere. Its principal uses include measurement of a material's thermal stability and composition. In the present study, The Q500 research-grade thermogravimetric analyzer was used at the Ilse Katz Institute for Nanoscale Science & Technology of the Ben Gurion University of the Negev.

Thermal analysis has been employed in several archaeometric studies to estimate the firing temperature of ancient ceramic materials (e.g., Moropoulou et al. 1995; Krapukaitytė et al. 2008). However, it should be stressed at the outset that this approach is not without constraints. When ceramic materials are fired, the most significant mass loss is typically associated with four reactions (Rice 2015: 99-116): (a) Loss of mechanically combined water at ~100-200 ºC. (b) Combustion of organic material at ~200-500 ºC. (c) Dehydroxylation of clay minerals such as kaolinite or montmorillonite at ~400-650 °C. (d) Decomposition of carbonates occurring at ~700-900 ºC.

The application of thermal analysis to examine ancient pottery fragments and estimate their maximum firing temperature relies on the basic assumption that, upon experimental reheating, those changes that are considered to be irreproducible will take place only when the upper limit of the original heating is surpassed (Drebushchak et al. 2005: 622). The decomposition of hydroxyls and the decomposition of carbonates are frequently regarded as irreversible reactions that indicate a maximum firing temperature below ~400-650º C and ~700-900º C, respectively (e.g., Meyvel et al. 2012). However, as pointed out by Drebushchak et al. (2005), the role of post-firing processes occurring during hundreds or even thousands of years of deposition under ambient conditions is significant in this respect. Three aspects deserve special attention: First, after ceramics are fired, mass gain takes place due to a set of slow reactions produced in the newly formed meta-clay by adsorption of water from the environment and recovery of some structural hydroxyl groups (Shoval and Paz 2013). Wilson et al. (2012) describe the mass of a typical archaeological pottery sample as the sum of five components: mass of the total inorganic mineral assemblage which remains intact after reheating the sample to 500 ºC + non-refractory component; organic materials such as food residues, microbiological contaminants, absorbed humic acids, etc., as well as minerals unstable at low temperatures.

Secondly, Dehydroxylation is not fully irreversible, since it has been demonstrated that ceramics gain mass and expand continuously after firing as a result of rehydroxylation, i.e., chemical recombination with environmental moisture (Hamilton and Hall 2012).

Thirdly, Secondary calcite or evaporites (gypsum, anhydrite) can occur in archaeological ceramics, either as a completely allochthonous component (precipitated from calcium carbonate saturated solutions percolating through the soil) or as a partly allochthonous component (Ca present in the pottery fragment + external C and O) (Fabbri et al. 2014 with references). Thus, the detection of mass loss in the range of ~700-900ºC may be due to the decomposition of secondary carbonates (Tschegg et al. 2009). Given all these constrains, TGA can still be a highly useful tool for distinguishing phases resulting from high temperatures in closed assemblages of artifacts, such as archives of cuneiform tablets.

In the present research project, TGA was used to examine the habit of firing letters in the Egyptian court. Since cuneiform tablets were a relatively new technological device in Egypt during the 18th and the 19th Dynasties when cuneiform script was introduced as part of the international correspondence, it is interesting to see whether the Mesopotamian scribal habits of firing letters was adopted. Two groups of letters were selected. The first were Egyptian letters unearthed at el-Amarna, the city of Akhetaten founded by Amenhotep IV (18th Dynasty) as his new capital (Moran 1992). The second, dating to roughly 70 years later, was a group of letters sent from Egypt to Ḫatti, dating for the most part to the reigns of Ramses II of Egypt and Ḫattušili III of Ḫatti (Edel 1994: 17-18).

The petrographic and pXRF analyses indicated that the letters from el Amarna were made with clay from the Esna shales, i.e., shales belonging to the upper Paleocene to lower Eocene Esna Formation which outcrops in several localities in Upper Egypt (Said 1990; Goren et al. 2004: 28). The Ramsesside letters found in Boğazköy-Ḫattuša were made of the so-called Marl D clay as defined by the "Vienna System" (Nordström and Bourriau 1993: 168-

182). This indicates a shift in the preferences of clay from a type that was never used for pottery production to a common type used for the production of predominany amphorae (Goren et al. 2011).

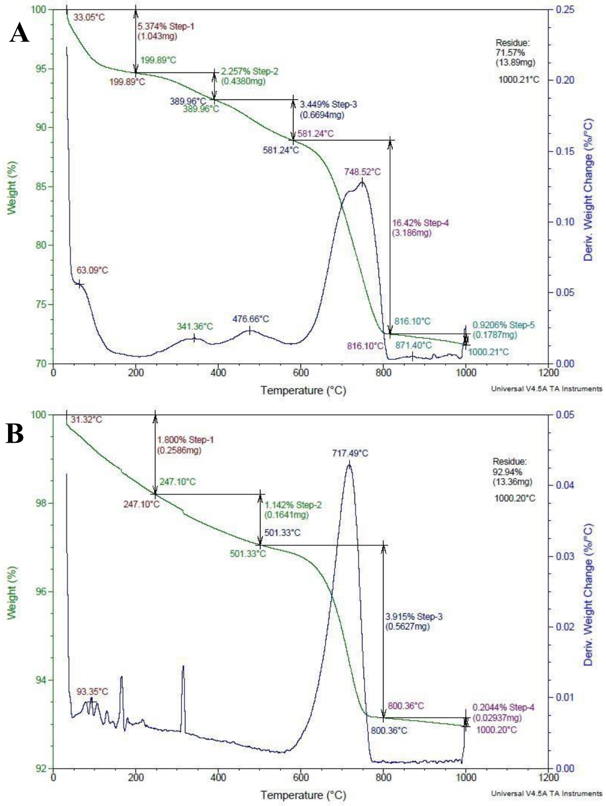

Figure 4: TGA graphs of (A) EA 190 from el Amarna, and (B) VAT 6168 from Boğazköy-Ḫattuša.

Four fragments from the times of Ramses II (VAT 6161, 6168, 6172, 13067) and one letter from el-Amarna (EA 190) were analyzed using TGA. The mass of the samples was ~10-25 mg. Measurements were carried out from room temperature to 1000°C, at a heating rate of 10°C min-1, in static air. According to J. Marzahn (pers. comm.), head-curator of the cuneiform collection at the Vorderasiatisches Museum, there is no record that the tablets stored there were fired for conservation purposes. The mineralogical changes observed in the 13th century fragments suggest that their average maximum firing temperature was higher than that of the locally produced Amarna tablets examined by Goren et al. (2004).

This difference seems to be confirmed by the TGA results. Figures 4A and 4B show, in a comparative manner, the reactions produced upon experimental reheating in one sample from each group (EA 190 and VAT 6168, respectively). As we pointed out, post-firing processes have to be carefully considered in order to assess the correlation between mass loss and maximum firing temperature. Since the thin sections of the fragments from Ḫattuša exhibit signs of firing at ~700-900 ºC, mass loss below and at this range should be connected with the following processes: (a) elimination of moisture water and non- refractory components (~100-500ºC), (b) dehydroxylation of clay minerals (~400-650°C) and (c) decomposition of secondary calcite (~700-900 ºC). For the thirteenth-century documents, mass loss in the range of ~400-650°C is consistent with the elimination of chemically combined rehydroxylated water acquired during the lifetime of each sample after firing (for VAT 6168: ~1%). However, the values of EA 190 are higher in this range (~4.5%), and also between ~700-900ºC. This differing pattern can probably be attributed to a set of reactions occurring above the original maximum firing temperature, i.e., the dehydroxylation of clay minerals and the decomposition of carbonates. It should also be noted that the loss of mass of the Ḫattuša fragments at ~700-900ºC seems to be produced by the decomposition of secondary calcite; in fact, a considerable amount of this mineral was observed by thin-section petrography. But in conclusion, we may deduce that between the 14th to the 13th centuries BC, Egyptian cuneiform letters on clay have undergone a process of adaptation resulting in the adoption of more suitable clays and higher firing temperatures, to secure safe arrival of the letters without damage or fraud.

B. Archaeomagnetic dating

The magnetic field of the earth is constantly varying in an unpredictable manner, posing significant challenges to earth physicists and geologists alike. Yet this irregular variation offers a means of constraining the dates of past events, provided that the variations during the period in question have been thoroughly documented (e.g. Kovacheva et al., 2014). The present study, only preliminarily presented here, is a unique step toward such documentation using clay samples from cuneiform tablets to assess their absolute age.

The magnetic force generated by the Earth ("the geomagnetic field") is a vector, pointing to different directions at different locations. In the simplest approximation, the magnetic field has a horizontal component that tends to point to the geographic north, aligning the needle of the compass along meridians. The vertical component is manifested by inclination of the vector from the horizon, which depends largely on the latitude. The strength of the field (magnetic intensity) also varies with location on the earth, principally depending on latitude, and typically increasing by a factor of two from the equator to the poles. The temporal variation of direction and intensity of the field at any region forms the basis for the paleomagnetic clock.

A key to dating of past events with paleomagnetism lies in the property of certain natural and artificial materials to store information about the magnetic field. Such materials are known as ferromagnets. This is the basis of magnetic recording in what is becoming outdated sound technology. Ferromagnetism of each such material is possible only below a critical temperature, so the ferromagnetic information stored is related the time of the last cooling of the object below the critical temperature. Objects that had kept their orientation since the last heating event can potentially store some directional information of the geomagnetic field. For obvious reasons, this part of the field is simpler to extract than the intensity of the field. Measurements of the intensity of the field are significantly more complex and less unique, requiring that the artefacts in question carry special magnetic properties. The paleointensity experiments assume that the magnetic carriers examined are single domain (SD). These are extremely small particles, with sizes of up to about 80 nm (Tauxe 2010), in which all magnetic spins are aligned and are uniformly magnetized. In previous studies, mostly lava flows and archaeological artifacts were measured. The former enables research of the paleointensity over long periods of time, whereas the latter enables the construction of a high-resolution record of the fluctuations.

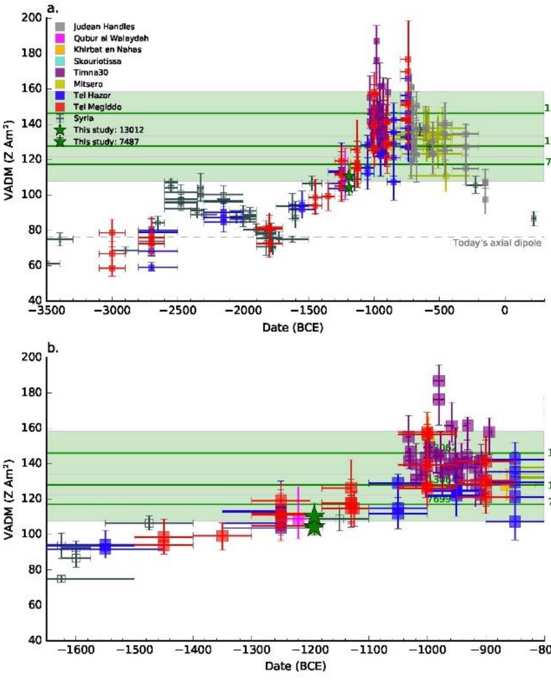

Figure 5: The tablets from Ḫattuša on the Levantine archaeointensity curve (LAC) (top section) and close up in the Late Bronze Age (bottom section)

The paleointensity experiment is laborious and time consuming, and often only after completion of the experiment the results may be accepted or rejected, depending on the magnetic behavior during numerous cycles of heating and cooling. Both lava rocks and archaeological artifacts have yielded a small success rate of 10-20% (Valet 2003). That is to say that only 10-20% of the specimens or samples that were used for the experiment exhibit qualities sufficiently high to be used for the paleointensity determinations, mainly due to the failure of the SD particle size assumption.

Our research group recently examined for the first time fired cuneiform tablets as a new material for paleointensity studies. The high temperatures observed in several instances through other analysis and rapid cooling rate to form “slag”, are a good potential for the creation of SD magnetic carriers which are the basis of a successful paleointensity experiment. Moreover, the use of iron-rich clay sediments for tablet production, often attested in our previous analyses (Goren et al. 2004 with further references), provides a solid body of data for such studies.

Previous projects focused on archaeo-metallurgic slag deposits which enabled reconstruction of field variations in the Levant (Shaar et al. 2011 with references). Slag deposits have the advantage over baked clay that they have undergone melting. Acquisition of the ancient field took place shortly after crystallization of the minerals that compose the slag. This had seemed as an advantage that lured the paleomagnetic lab of the Hebrew University to explore the behavior of slag. The additional advantage of slag deposits is the ability to re-melt them, cooling them under controlled conditions (magnetic field, cooling rate, and atmosphere). Thus, we can validate our laboratory procedures for accurately estimates of the ambient field during cooling (Shaar et al. 2011). The present research builds on this innovation by application of the method to fired and overfired clay tablets from selected archives and periods, thus far yielding a promising pilot study of selected tablets from Boğazköy-Ḫattuša (Fig. 5).

V. REE PATTERNS IN EPIDOTE

Another pilot project of our group will refer to the case of Alashiya. For more than a century the location of the Bronze Age kingdom of Alashiya (or Alašija) has continuously been debated. The textual evidence indicates that during the 14th and 13th centuries BCE Alashiya maintained economic and political contacts with Egypt and north Syria. The documents suggest that it produced and exported large amounts of copper and that it was an independent state. Most scholars associate it with part or all of Cyprus. A minority view considers the data circumstantial and inconclusive. Scholars advocating the latter view tend to identify Alashiya in either Cilicia, or part of north-western Syria (c.f., Merrillees 1987).

Provenance studies of the letters dispatched from Alashiya to el Amarna in Egypt and Ugarit (Goren et al. 2003a; 2004: 48-75), or to Ḫattuša (Goren et al. 2011), indicated them to be made of several types of Cypriote clay formations. Using petrography, ICP-MS, INAA and pXRF, the sources were found to be the circum-Troodos

Pachna and Moni formations and clays developed on the pillow-lava and dolerite units of the Troodos ophiolite. These included typical detrital minerals and rock fragments, such as plagiogranite, micro-gabbro, dolerite, greywacke and epidote. Such features are known also from studies conducted on Cypriote ceramics (e.g., Boness et al. 2015 with references). Although the identification of Alashiya in Cyprus on the basis of these data was broadly accepted, a minority still rejects it (Merrilees 2005).

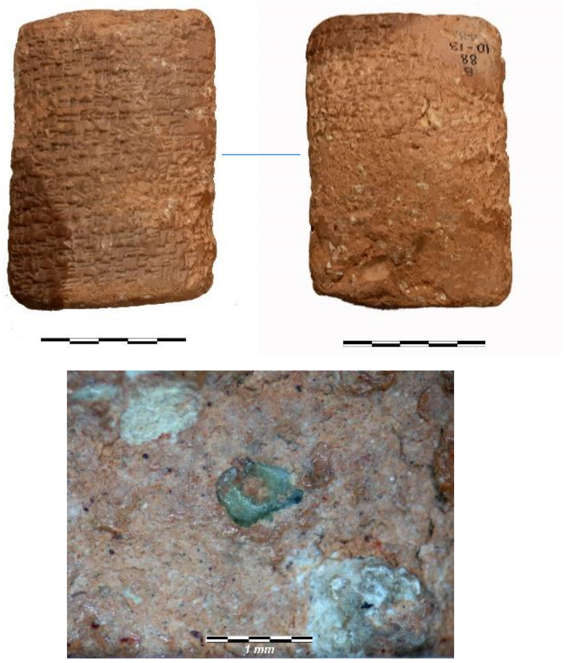

Figure 6: Tablet EA 37 from el Amarna, a letter from the King of Alashiya to the Amenophis IV of Egypt. Bottom: Stereomicroscope view of an epidote grain in EA 37.

'Le croissant ophiolitique peri-Arabe' (Ricou,1971) refers to an arcuate band of ophiolites, going all the way from Oman to Cyprus marking the suture between Africa (or Arabia) and Eurasia. The peri-Arabian ophiolites represent Tethyan oceanic lithosphere of Upper Cretaceous age that was emplaced on top of the adjacent Arabian continental margins shortly after having formed in an oceanic spreading center. Thus, it is an unfortunate coincidence that ophiolitic occurrences of similar age can be found in each and every area suggested for the location of Alashiya. Nevertheless, the extent of deformation, the relative abundance of the various oceanic rock types and the internal organization and structure of the peri-Arabian ophiolite massifs vary and we intend to highlight these aspects through the examination of several markers in the samples collected from an assembly of ANE cuneiform tablets. In particular, the Troodos ophiolite of Cyprus, the westernmost member of the belt, differs in several features from other Eastern Mediterranean ophiolites like the Mersin and Pozanti-Karsanti massifs of Cilicia, the Kizildaĝ massif of Hatay Province, Turkey, and the Baër-Bassit massif of northwest Syria. Troodos is also of Upper Cretaceous age, but unlike its counterparts it preserves a non-deformed, well-ordered, and nearly intact section of oceanic crust.

When magma and water closely interact, like in oceanic spreading centers, hydrothermal activity arises. The well-exposed crustal section in Troodos facilitates the study of an entire fossil hydrothermal system from bottom to top, including the parts of this fossil system that formed well below the seafloor, which are inaccessible in active systems of the modern ocean floor. For example, metals in ocean floor hydrothermal vents ('black smokers') are thought to originate mostly from leaching of subseafloor crustal rocks by heated seawater (Cann and Gillis, 2004). However, studying the rootzone of the hydrothermal system in Troodos revealed another possible metal source: degassing of silicic magma crystallizing as plagiogranite plutons at the top of the lower crust (Anenburg et al., 2015). This unique metal source was tracked by studying the geochemical composition of the hydrous mineral epidote, highly abundant in the Troodos plagiogranites, and especially by its Rare Earth Elements (REE) pattern. The question is whether metals, including REE, contained in exsolved magmatic fluids are able to migrate through the plagiogranites into nearby and overlying rock suites, the sheeted dolerite dykes, which are considered the conduits of the oceanic hydrothermal system (Bickle and Teagle, 1992; Gillis, 2002). Furthermore, is the unique metal-rich chemical signature of magmatic fluids carried upwards through the middle and upper oceanic crust to enhance mineralization on the ocean floor? Unlike Troodos, where plagiogranites and epidotized sheeted dolerite dykes are widely exposed, in other Eastern Mediterranean ophiolites they are relatively less abundant (Robertson, 2004), and the unique magmatic contribution to the hydrothermal fluids was not detected.

Here we will use geochemical fingerprinting of the hydrothermal mineral epidote (Fox et al., 2018), as means to distinguish between epidote detritus in clay samples from different ophiolitic environments, which in turn will be employed for provenance determination of tablets and other ceramics from ophiolithic environments. In this project, we intend to use the case of Alashiya as the basis for broadening the spectrum of analytical methods used for provenance studies of clay-derived artifacts such as cuneiform tablets. By combining our previous research track record, we intend to examine this aspect from a new angle, untested thus far.

At present, the study includes several samples of documents from Alashiya from el Amarna (two letters) Ḫattuša (one letter), taken in 2002-5 from the tablets in the British Museum and the Vorderasiatisches Museum in Berlin. In addition, the thin sections that were made from the Alashiya tablets and other relevant locations (e.g., Ugarit) are being used now by carefully grinding their cover slips to expose in each the polished sample, then the entire thin section will be coated and the epidote clasts analyzed. Coupled together with the previous work, the results of this study will address the arguments of the last opponents of the identification of the Kingdom of Alashiya with the area near the Troodos Mountains in Cyprus or elsewhere.

VI. CONSERVATION, SCIENCE AND ETHICS

The ongoing analytical study of cuneiform tablets, a research project enduring for quarter of a century now, is representative of many problems occurring in modern heritage science. Over the years, the constant introduction of novel and innovative analytical methods has constantly broadened our scope, enabling the investigation of an increasing number of questions. From merely provenance study using the conventional methods of petrography and INAA, this project shifted to specific branches such as the firing of Egyptian letters, dating selected texts from Boğazköy-Ḫattuša or the use of one mineral to further disclose location of Alashiya. With the advent of new apparatus offering better NDT or MDT of sensitive heritage objects such as tablets, there seems to be an endless choice of possibilities.

Figure 7: Examples of degradation of tablets in the British Museum. Left: crumbling. Right: salinnation. (Photos by Y. Goren)

At the same time, museum curators and conservators are facing serious problems. The removal of great numbers of clay tablets, often unfired or lightly fired and affected by post-depositional processes, from their usually arid environments in the ANE to other climatic conditions in Europe or North America, presents countless problems. The survival of these collections is threatened, as serious deterioration, lamination and powdering problems are affecting these artefacts. In addition, tablets are daily studied and handled by scholars, as they are available to the scientific community for research. The decay of these archives represents a loss of cultural heritage for humanity. This reality calls for increased collaboration between scientists and conservators and the application of efficient and standardized predictions of preventive and remedial conservation actions. While there is the natural tendency of each institute to take care of its own collection, the present reality calls for the establishment of protocols for the research, conservation, restoration and storage of tablets for the benefit of future research and education. Into this broad topic enter the advances in the application of scientific methods. All these require some new thinking, taking in consideration aspects of research and conservation and coordinating between them.

A good example can be seen in the treatment of tablets by The British Museum (BM). Being primarily a 19th century collection, it mainly comes from sites around Mesopotamia, with smaller numbers from the wider cuneiform world (including Old Assyrian, Chagar Bazar, Alalakh, Tell Brak, Amarna), with large corpora from Nineveh, Sippar, Babylon and Girsu. The collection has always shown some deterioration, as historically it was exposed to fluctuating relative humidity. Therefore, some of the deterioration visible today could be related to previous unstable conditions associated with the storage of the tablets. Heating and ventilation were installed in the Museum in the mid-19th century, also affecting the objects. Different types of deterioration could be observed, including powdering, lamination and flaking. A range of salts, as well as mixtures of salts, were identified (e.g. calcium sulphate, calclacite and anhydrite thecotrichite, acetate and formats) (Thickett and Brookes 1998). Some of these were associated with the storage environment. The deterioration varies widely and the most affected seem to be the unfired tablets. As well as cracking, insoluble salts are obscuring the texts. From the 1950's until early 1990's firing was considered the only option for all tablets whether they were in good or poor condition (Parkinson 1950; Guinan et al. 1976). It was assumed that removal of soluble salts during desalination maintained their long-term stability. The conservators at the BM treated the tablets by firing and desalinating them, however many tablets continued to be affected by salt formation. Overall, ca. 35% of the collection was fired. However, statistical surveys carried out in 1987 and 1993 concluded that firing of all tablets, regardless of their condition, was unnecessary, leading to the end of this practice.

This massive unsuccessful "experiment", resulting from what appears now as a flawed concept, was motivated by conservation considerations alone but without any attempt to test it over some time on a small number of items and comparisons with a control group. The firing of thousands of tablets to temperatures of ~700-900ºC, not only provided barren results but also erased forever any possibility of their dating by archaeomagnetism or testing their ancient technology by methods such as TGA. This should serve as model case for the need of open and fluent communication between the curator, the conservator and the scientist.

ACKNOWLEDGEMENTS

This research project was supported by the following funds: German-Israeli Foundation (GIF) grant No. I-1016-272.4/2008: ' An Interdisciplinary Approach to the Study of the Hittite Archives from Bogazkoy/Hattusha and Other Sites'; Israel Science Foundation Grant no. 241/15: ‘The Production and Dissemination of Scholarly and School Textual Materials during the Late Bronze Age: An Integrated Research Project’. This project has also received funding from the European Union's Horizon 2020 research and innovation programme H2020-MSCA- ITN-2017- EJD: Marie Skłodowska-Curie Innovative Training Networks (European Joint Doctorate) – Grant agreement n^{o}: 766311 – ED-ARCHMAT (ESR6). An internal fund by the Ben Gurion University of the Negev was granted to the project 'On Kingdoms and Grains: New Approach to the Identification of Alashiya'. We wish to thank our many colleagues in these sub-projects.

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