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ABJAD NUMERALS AS AN ABSOLUTE DATING METHOD: FORTS FROM AL-AIN, UAE

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ABSTRACT

The Abjad numerals are a decimal system, where the numerical value of the 28 Abjad letters are used to denote construction dates in a word, phrase or a hemistich inscribed on the façades of old Islamic buildings. The system is precise and accurate but has only been researched sporadically. Therefore, this study is concerned with describing, analyzing, and documenting the historical dimension and the major uses of the Abjad numeral system in the Arab region. It illuminates its use as a poetic chronogram to determine the construction dates of two case studies in Al-Ain (UAE); al-Jahili Fort and the Eastern Fort, which have been dated to the late 19th and early 20th centuries, respectively. The engraved verses (poems) are deciphered and discussed in comparison to other parallel examples from Jordan, Saudi Arabia, and Egypt, in order to determine the major characteristic features of poetic chronograms. Additionally, the study traces the roots of the idea of assigning numerical values to the writing signs in Mesopotamia and its surrounding region since the late third millennium BCE. It concludes that using Abjad numerals embedded in a word in a chronogram is similar to the Greek inscriptions found from different archaeological sites in the 3rd and 4th centuries CE, while the earliest recorded poetic chronogram relates to a later date around the 14th century. Finally, the study recommends that further documentation of chronograms should be undertaken, due to their historical value as well as the necessity to provide an accurate, absolute date for individual structures.

KEYWORDS: chronogram, dating, ḥisab al-Jummal, ta'rikh, fort, inscription

1. INTRODUCTION

Determining the date of an archaeological site or an old building is always considered a priority for archaeological research, in order to fully understand past human behaviour over time. Thus, archaeologists have developed more than one dating technique to obtain decisive results for archaeological sites, but nothing can compare to finding a coin or an inscription which bears the absolute date. One accurate method which has been used is the Abjad numeral system, where the inscription on the façade of a building includes the construction date.

Abjad numerals are a decimal system based on assigning a numerical value to each of the twenty-eight Arabic letters. Assigning a numerical value for letters is an ancient practice used initially by Greeks, Jews and Syriacs, and later by Muslims. While the earliest archaeological evidence for using Greek alphabetic numerals has been credited to western Asia Minor in the 6th century BCE (Chrisomalis, 2010), the earliest recorded evidence of the use of Abjad numerals by Arabs appears to post-date the advent of Islam.

Limited research and documentation have been conducted for Abjad numerals. The sporadic information concerning the use of Abjad numerals during the Islamic Periods has increased the difficulty of using them. The sparse published chronograms made tracing geographical distribution and development of chronogram types (see Section 3.1 for more detail) difficult. Moreover, no previous study, as far as could be determined, made comparisons between Arabic chronograms (which used Abjad numerals) with other, earlier systems (such as Greek chronograms) to trace cultural influences. The only three previous studies which were available to the researcher attempted to either discuss Abjad numerals in general, or to use chronograms to date construction. The first lists 154 chronogram inscriptions embedded in Islamic architecture in Egypt (Ibrahim, 1994), the second concentrates on chronograms used in Arab poetry *diwans* (books containing collections of poems; al-Sadhan, 2008), and the third focuses on the religious perspective of the secretive nature of letters and *ḥisab al-Jummal* (calculating Abjad numerals) by religious Islamic sects such as Sufism and Twelver Shi'ism (al-Qahtani, 2008-2009). Thus, despite the importance and usefulness of these three studies, they discuss Abjad numerals from a different perspective than the current one, which investigates the earliest evidence at a deeper level, based on the origin of the idea to assign a numerical value to writing signs. Furthermore, the two inscriptions from Al-Ain, which are a key focus in this study, have not been studied in any of the preceding articles; by directly examining their location, providing photographic evidence, and deciphering their poetic chronograms, it is possible to compare these examples to other parallel examples, mainly from the Arab region which have been published previously.

The methodology used for this study comprised collecting, describing, analysing and documenting the available data. In some cases, it was necessary to review original publications in order to verify if the data was accurate, which led to specific conclusions in some instances.

The first section of this study traces the origin of assigning numerical values to written signs (either syllabic or whole word); the evidence points to Mesopotamia and its periphery as the initial instigator, and verifies that this region was the first to use numerals to represent syllables or words, thus preceding the alphabetic numerals which the Greeks invented at a later date, and developed into an organized system. Some early Greek inscriptions are discussed, to show the impact of the Greek numeral system in the development of the other numeral systems. In the second section, the study discusses the terms used for the Abjad numeral system in the Islamic sources, their earliest appearance and the different uses to which they were put. The first appearance of Abjad numerals occurred in the 8th century CE, with three major categories; magic and divination, practices related to religious interpretation, and literary and scientific purposes (the chronogram case studies which form the basis of this study fall into the latter category). The inscriptions surmounting the gates of the two forts in Al-Ain are deciphered and discussed for the first time in the third section of this study, which enables their construction dates to be determined. Finally, the poetic nature of the chronograms is compared with other published parallel examples from the Arab region; although the number of examples is limited, it is possible to determine the major characteristic features of its use. The main objective of this study is to trace the historical dimension and major uses of Abjad numerals in the Arab region, focusing on its precise and simple method of dating (the chronogram). The importance of poetic chronograms is discussed, to determine the construction dates of two case studies in Al-Ain (UAE); al-Jahili Fort and the Eastern Fort, which have been dated to the late 19th and early 20th centuries, respectively.

2. FROM AN IDEA TO A SYSTEM

There has been a consensus between scholars to attribute the invention of alphabetic numerals to the Greeks. Ifrah (2000) adopted this view and called it the "Greek hypothesis", according to the archaeological discovery of an inscription on the Acropolis in Athens dated to the 5th century BCE. Chrisomalis

(2010) agreed with this, based on discoveries in the Ionian cities of Caria (such as Miletus on the coast of modern Turkey), although in a previous paper (in 2003) he had criticized the assumption "that the Greek alphabetic numerals were independently invented in the 6th century". Later (in 2012), he proposed there had been two stages; during the first stage, the Greek alphabet developed from its ancestor, Phoenician Abjad, with the Ionians on the western coast of Asia Minor later integrating the alphabetic ordering with the demotic principles of ciphered numbering in the second. Some scholars, such as Barry (1999) believe that, even though the Greeks developed alphabetic numerals, they may have been influenced by the numeral system of language which was used by the Assyrians. Earlier scholars such as Pearce (1982), while studying cuneiform cryptography for her PhD thesis, argues that numerical substitution for specific words or syllables in cuneiform texts probably preceded the Greek system, which was later adopted by the Hellenistic Jews as gematria.

However, the epigraphic evidence confirms that the idea of assigning numerical values to some of the writing signs (syllabic signs or words) appeared in Mesopotamia and its periphery much earlier than the stage of assigning numerical values to the letters and three categories can be distinguished;

1. assigning a numerical value for syllables within a word
2. assigning a numerical value to a whole word, and
3. determining that the total numerical value of the syllabic signs of one word (for example, the king's name Sharru-kin) is equal to the total value of other words (total of measurement units of the city wall).

The first category is based on assigning numerical values to syllabic signs, such as using the number 6 to represent the syllabic value of *àš* in the divine name *Ašķi = 6.KI*, which has been dated to the late Sargonic and Ur III Periods (late third millennium BCE) and used again during the Middle Babylonian Period (Pearce, 1982). The syllabic signs *min, I, u, niš*, and *eš* were substituted by the numbers 2, 5, 10, 20, and 30 respectively (Lieberman, 1987).

The second category appeared in Mesopotamia, where the names of deities were symbolized by specific numerals. These numerals were then used instead of words to write these names, with the first evidence dated to the Old Babylonian Period (Rölling, 1957-1971). An important text (Tablets K170 + Rm 520 = CT 25:50 + CT 46:54) from the Kouyunjik Collection dated to the Neo-Assyrian Period includes a guide to the major deities' names, their equivalent numerals, and mythological and theological comments for each deity (Pearce, 1982; Livingstone, 1986; Pearce, 2005). This text indicates the continuation of a practice which started much earlier in the Old Babylonian Period. Each deity was assigned a specific number, such as 30 to *Šin,* who represents the Lunar Cycle, and 15 to *Ištar*; the daughter of *Šin*, and thus worth half, while the number 20 was assigned to *Šamaš,* who represents the sacred twentieth day of each month (Landsberger, 1915; Rölling, 1957-1971). The assigned numerals, it seems, reflected the role these deities played in Mesopotamian society, according to religious and cosmological conceptions. Other evidence related to this category has been discovered in the periphery of Mesopotamia. Firstly, in old Babylonian Susa, the words *šarru* (king), *kussû* (throne), *imittu* (right) and *šumēlu* (left) were replaced by the numerical values 3,20, 1,20, 15 and 2,30 respectively (Pearce, 1982). Secondly, the inscription on the statue of King Idrimi from Alalakh, dated to the 16th century BCE, bears the cryptogram "X XX XXX" in Line 98; it has been suggested that this represents *Adad, Šamaš,* and *Kušuh*, according to the numerical value of their names (Pearce, 1982).

So far, the only example related to the third category is from the Assyrian city Dur-Sharrukin (Khorsabad), which reveals the practice of formulating the sum of the numerical values of each syllabic sign which can be identified in one name. A clay cylinder inscription dated to the Assyrian king Sharrukin (Sargon II, 721-705 BCE) states that the wall of Khorsabad was built by the king and measures 16,280 cubits, which corresponds to the numerical value of his name (Lyon, 1883; Luckenbill, 1927; Pongratz-Leisten, 2015). Lyon (1883) calculated the sum of 16,280 based on the original text as follows; "IV sar, III *ner*, I *šûš*, III *kane*, II *ammat* {=16,280 cubits} *nibit šumê'a*". Delitzsch (1878) interprets the value of the wall perimeter in more detail = 4 × 3,600 + 3 × 600 + 1 × 60 + 3 × 6 + 2 = 16,280 cubits. Other scholars simply note that the total is 16,283 cubits without further explanation (Luckenbill, 1927; Barry, 1999; Ratzan, 2004).

However, the correspondence between the perimeter of the wall (that is, 16,280 cubits) and the numerical value of Sharru-kin's name has not been proven definitively (Pearce, 1982; Radner, 2005). This inscription is considered to be extremely significant, as it represents the earliest discovered text with a direct indication that numerical values were assigned to syllables, and thus the total value of Sharru-kin (Sargon) should be equal to the circumference of his city. Consequently, this practice preceded the Greek isopsephy and the Jewish gematria. Also, the inscription "*nibit šumê'a*" which means either "the number of my name" or "the spelling of my name" (Pearce, 1982) is similar to the word "*simiya*" that was used by ibn Khaldun to indicate the science behind the secrets of

letters (ibn Khaldun, 1967c; for a more detailed discussion of the meaning of *simiya* see also MacDonald and Fahd, 1997) and it may consequently reflect the longevity of this ancient practice, which may have originated in Mesopotamia and which simply indicates the numerical value of the written signs for a name.

This epigraphic evidence leads us to conclude that the idea of assigning numerical values for written signs first emerged in Mesopotamia as early as the late Sargonic and Ur III Periods, with the area of its use expanded to include its periphery (for example, Susa and Alalakh) by the first half of the second millennium. Consequently, assigning numerical values to some writing signs (whether syllables or whole words) or calculating the sum of the numerical values for syllables clearly preceded the letter numeral invention (both the Greek alphabetic numerals and the Greek isopsephy). The limited number of examples in Mesopotamia is noteworthy, and can be explained by the existence of other well-established numeral systems, such as the sexagesimal and decimal systems. In addition, assigning numerical values to written signs, as detailed in the examples above, does not appear to have been used for either commercial or general reasons, but restricted to other, specific purposes. On one hand, the names of deities were assigned specific numerals based on a religious concept which correlated with their astronomical explanation; this substitution may indicate "a sacred or religious practice". Values for words such as "king" and "throne" from Susa, or later by the Assyrian king's name Sharru-kin can be interpreted either as a separate "political use", or as an extension of "religious practice", to indicate the greatness of the king, or that he was blessed by the gods. On the other hand, words such as "right" and "left", with numerical values 15 and 2,30 respectively, have been explained by Schott (1938), based on two historical documents. Firstly, he postulates the numerical values relate to the amount of time the moon is visible at the start of the month (15) and at the end of the month (2,30); this explanation is based on 80-7-19,273g (a fragment of Tablet 14 from *Enuma Anu Enlil*). Secondly, founded on his examination of the series of *Mul.Apin* (astronomical tablets), he proposes that the calculations depend upon a south orientation. So the numerical value of *imittu* (right) is the amount of time the moon is visible on the third day (the new crescent) = 15 to the right (west), while *šumēlu* (left) is the amount of time the moon is visible on the twenty sixth day (the gibbous) = 2,30 to the left (east) (Schott, 1938; Pearce, 1982). This correlation may indicate the importance of astronomy, based on assigning these two numerals, thus reflecting an "astronomical or scientific use" for the substitution.

But how could this idea reach western Anatolia (Ionia)? Dalley and Reyes (1998) note that words related to *Ionia*/*Ionian* appear for the first time in inscriptions related to the Neo-Assyrian Period (for example, in an inscription which states the land of Ionia had paid tribute to Esarhaddon) and also in the Neo-Babylonian Period (for example, in inscriptions which describe importing bronze, iron and purple wool from Ionia or that Ionian carpenters were living in Babylon). Additionally, there is evidence that the Lydian ruler Gyges asked the Assyrians for assistance to defeat the Cimmerians during the reign of Ashurbanipal 668-635 BCE (Grayson: 1991: 145-146). Therefore it is reasonable to assume, according to these Mesopotamian records, that the idea was introduced to western Anatolian cities via the political and commercial contacts which existed between west Anatolia and Mesopotamia in the first half of the first millennium BCE, where it developed further, into the letter-numerals system. Confirmation of this may be hidden within yet to be discovered Mesopotamian inscriptions from Anatolia (such as Harran), which include syllabaries or word-numeral substitution.

Further, reports quote alphanumeric keys which correspond to Linear B syllabograms (alphabetic numbers representing Mycenaean numbers) (Verdan 2007).

2.1. *The Greek Alphabetic Numeral System: Early Examples*

The Greek alphabetic numeral system was the first to be invented and can be traced back to the 6th century BCE; the earliest examples are from the city of Miletus. The system includes the twenty-four Greek letters, together with three additional signs; digamma (6), qoppa (90), and san or sampi (900), which were added to obtain 27 signs for all the values from 1 to 900 (Chrisomalis, 2010). The first nine letters represent the units 1 to 9, the second nine represent the tens (10 to 90), and the third nine represent the hundreds (100 to 900). The Greek alphabetic numerals were used for general cases related to mathematics, and also for number mysticism. The close connection between the Greek letters and numbers enabled Pythagoras, a Greek philosopher who lived around 580-500 BCE, to invent divination by isopsephy, which is known today as Pythagorean numerology (Barry, 1999).

Following the conquest of Alexander the Great and during the Hellenistic Period, the use of Greek alphabetic numerals flourished, spreading widely across the Near East, and appear on coins from the Phoenician cities of Sidon, Tyre, Byblos, and Akko from the mid-3rd century BCE onward (Chrisomalis: 2010), and also on the coins from Ptolemaic Egypt (Barry, 1999). As a result of the Greek cultural influence which was

endemic in the wider region, the Hebrew letter numeral system is derived from that used by them; the earliest examples appear on Hasmonean coins dated from 103 to 76 BCE, while the Syriac letter numerals probably developed during the 6th century CE (Chrisomalis: 2010).

The Greek isopsephy continued to be used into the Roman and Byzantine periods. A well-known graffiti from Pompeii, dated to c.79 CE, can be read as "I love her whose number is 545" (φιλώ ης αριθμός φμε; Barry, 1999). Another example was recorded by Suetonius (a Roman historian, born 69, died after 122 CE) on the wall of Rome; recalling the murder of Agrippina (15-59 CE), he relates the name Nero (Νέρων) to the words "killed his own mother" (ιδίαν μητέρα απεκτεΐνε), where the numerical value of Nero's letters (50+5+100+800+5) = 1005 is equal to the resulting numerical value of the "killed his own mother" (10+4+10+1+50) + (40+8+300+5+100+1) + (1+80+5+20+300+5+10+50+5)=1005 based on the Greek numeral system **(**Barry, 1999; Ifrah, 2000**).** During the Byzantine period, Greek alphabetic numerals were used in the religious isopsophic phrases. The archaeologist Prentice recorded several Christian Greek inscriptions on tombs, churches and the majority of the dwelling-houses from Syria. He found an inscription in a tomb at Shnan in Syria, where the refrain Ιησούς Ο Χρειστος **(**Jesus the Christ) is written out in full, and then also expressed at the end of each line in the form ΒΥΜΓ. The form ΒΥΜΓ is the total numerical value of Ιησούς Ο Χρείστος (10+8+200+70+400+200) + (70+600+100+5+10+200+300+70+200) **=** 2443 = ΒΥΜΓ (Prentice, 1906; Barry, 1999). The same form ΒΥΜΓ is recorded from a five-line inscription at the ar-Rabba site (Karak governorate), Jordan. Although some of the inscription is unreadable, Gnoli (2002) suggests it is a tomb inscription (similar to that in Shnan, Syria) dated to the 5th-6th century CE.

Explicit dating type chronograms (see chronogram types in Section 3.1. and parallel examples in Section 4.3) appear in Greek inscriptions dated to the 3rd and 4th centuries CE (Roman and Byzantine periods), where the Greek alphabetic numerals are used to indicate the year of construction and preceded by the form "in (w/o the) year", as in the following two examples. The first inscription was found on a tomb lintel (n. 276) at Umm el-Jimal, Jordan; it includes following text: Μασεχω Ουαελου τό μνημείον, θανόντι ἐτ(ων) κγ΄. Ουαελος Ραουαου πατήρ ἐποίησεν ἐτ(ει) ριή. For Masik, (son) of Wail, who died (aged) 23 years, (this is) the memorial. Wail, (son) of Rawaḥ, (his) father, built (it) in (the) year 118. (=223 CE; Littmann et al., 1913). The second inscription was found on a broken door lintel from Odjeh in Syria; `Εν ἐτι ϛψ΄ἐτελέσθη. ὑπ(ὸ)κιμε πρός εὐψυχίαν τών ἐνθάδε κατ [οικούντων(?)]. In the year 706 (=394 CE). I am set for the peace of those that dwell here (Prentice, 1906; Trzcionka, 2004). Similarly, alphanumerics from byzantine churches/ monasteries pinpointing the date of construction was used for archaeomagnetic dating (Liritzis and Kovacheva, 1992).

This type of chronogram, used to date constructions, was inherited by the Islamic period (using Abjad numerals in place of Greek), where the words "in the year" also preceded the word used to indicate a direct mention of the year of construction.

3. ABJAD NUMERALS

Since letter order is very important for assigning numerical value, it is important to distinguish between the two well established writing systems used by Muslims; Abjad order and Arabic alphabetic order. The major differences between them are related to timeframe and usage. Abjad is an Arabic term for the traditional order of letters in the Arabic script, with a consonant assigned to each letter (Daniels, 1990). The first four letters of this order gave it its name Abjad *'alif, ba, jim, dal*. The major hypothesis regarding the origin of the alphabet proposes that the letters in the Semitic inscriptions from the mines of Sinai had been borrowed from Egyptian hieroglyphs by applying acrophonic principles in the 19th century (Colless, 2014). However, the roots of the Abjad order belong to a very ancient writing system which was invented by the Phoenicians around the 15th century BCE, which then spread to the four corners of the Mediterranean world (Ifrah, 2000). The Arabic script (Abjad) is descended from the Nabatean script (which is in turn descended from Aramaic), but the twenty-two Nabatean letters were not sufficient to represent the twenty-eight sounds of the Arabic language (Gruendler, 2012). Therefore, six additional letters were later added to the original Abjad letters; *tha, kha, dhal, ḍad, ḍha,* and *ghayin*. These are combined into two words (*thakhadh* and *ḍaḍhgh*) and known as *rawadef* (which means at the end) where they were assigned in the Abjad order (al-Isfahani, 1992). Only ibn al-Nadim (1997) disagrees with this; he includes the letter *shin* instead of *ḍad* within the six letters of the *rawadef*. The researcher considers this to be a mistake, because the letter "*shin*" already existed in the antecedent Phoenician script.

However, Arabic Alphabetic Order (that is, *alif-ba-ta-tha*) can also be used, which should not be confused with the Abjad order of *alif-ba-jim-dal*. While the Abjad system is based on consonants, alphabets in general should include both consonants and vowels (Daniels, 1990). Thus the Arabic alphabet, which is composed of 28 letters, has three letters (*alif, wa,* and *ya*) which represent both a consonant and a long vowel (Bauer, 1996). The Arabic alphabet was derived from the Abjad, by placing letters with similar shapes

together (Daniels, 1990). The early Islamic Period, with its increased number of non-Arab converts, required the script to include more phonetic details (Gruendler, 2012). The misspelling of words (particularly *tashif* in Iraq), caused by the fact that a number of letters have similar shapes, led al-Hajaj bin Yusuf al-Thaqafi (an Umayyad governor) to order his scribes to distinguish between these letters (al-Isfahani, 1992); the first step was to introduce the diacritical dots (*i`jam*), with the Abjad letters later rearranged into an alphabetic order based on the shape of the letters (Solomon, 2013). Therefore, the rearrangement of the Abjad letters into the Arabic alphabetic order occurred as a result of an increasing Islamic society's need to facilitate reading and learning of the Arabic language for non-Arabs, while the Abjad order, which was an ancient Semitic writing system (as noted above), continued to be used after the introduction of Islam for other purposes which are summarized below.

Basically, Abjad Numerals are based on the Abjad system, where each letter is assigned a numerical value. The 28 letters are divided into four categories; units (1 to 9), tens (10 to 90), hundreds (100 to 900) and thousands (1000). Each category includes nine letters, except for the thousands, which have only one letter; *Ghayn*. It is a decimal system, ciphered-additive below 1000 and multiplicative-additive above 1000 (Chrisomalis: 2010). It has been used over a vast area of the Islamic world, but the Abjad sequence differs between the Eastern and Western regions. The eastern Arabs invented eight mnemonic words according to their ascending numerical values (that is, 1, 2, 3, 4 and so on); *Abjad, Hawwaz, Ḥuṭṭy, Kalamun, Saʿfaṣ, Qarshat, Thakhudh*, and finally *Ḍaḍhugh*. However, the western Arabs used nine different mnemonics, based on grouping the letters according to their numerical values (1; 10; 100; 1000), (2; 20; 200), (3; 30; 300) and so on, using the words *Ayqash, Bakar, Jalas*, *Damat*, *Hanath*, *Waṣakh, Zaʿadh*, *Ḥafaḍh,* and finally *Ṭaḍugh*. (Ifrah, 2000). Accordingly, the numerical value of six letters is different between the eastern and western regions of the Arab world: *sin, sad, shin, ḍad, ḍha, and ghayin,* as demonstrated in Table 1 below.

Table 1: Abjad Numerals as they are used in the Eastern and Western Regions of the Islamic World. (Ifrah, 2000; Juste: 2011)

Abjad letters				**Phonetic value of letters**	**Numerical Value**
Eastern Region		**Western Region**			
أ	ʾAlif			ʾ	1
ب	Ba			b	2
ج	Jim			j	3
د	Dal			d	4
ه	Ha			h	5
و	Wa			w	6
ز	Zay			z	7
ح	Ḥa			ḥ	8
ط	Ṭa			ṭ	9
ي	Ya			y	10
ك	Kaf			k	20
ل	Lam			l	30
م	Mim			m	40
ن	Nun			n	50
س	Sin	ص	Ṣad	s	60
ع	ʿAyn			ʿ	70
ف	Fa			f	80
ص	Ṣad	ض	Ḍad	ṣ	90
ق	Qaf			q	100
ر	Ra			r	200
ش	Shin	س	Sin	sh	300
ت	Ta			t	400
ث	Tha			th	500
خ	Kha			kh	600
ذ	Dhal			dh	700
ض	Ḍad	ظ	Ḍha	ḍ	800
ظ	Ḍha	غ	Ghayn	ḍh	900
غ	Ghayn	ش	Shin	gh	1000

The same term is not always used for Abjad numerals in the Islamic sources. The most common is *Ḥisab al-Jummal* which ibn Khaldun (1967b) defines as "calculating the numerical value of the letters". It is also written as *ḥisab al-Jumal,* (Gacek, 2001). Other, similar terms have also been used, such as *ḥisab Abjad* (Gacek, 2001; Chrisomalis, 2010) which means "calculating Abjad letters", and *ḥuruf al jumal*, which can be translated as "totals by means of letters" (Ifrah, 2000). Ibn Arabi, a Sufi who lived between 1165-1240 CE, commented that some people used *al-Jummal*, while others used *al-Jazm* (ibn Arabi, 2011); this indicates that *al-Jazm,* an ancient Arabic script, was used when copying the Qur'an at al-Ḥirah (Gacek, 2001). The term Abjad numerals is used throughout the current study. It has been adopted because it is easily understood and is comprehensive for all examples and uses; not only the calculation of the Abjad numerals, but also from simple pagination to more complex chronograms. It also confirms the historical dimension, by connecting the arithmetic system to the Abjad letter order which already existed before the introduction of Islam.

3.1. Appearance and Use

Existing evidence indicates that Abjad numerals were not used before the 8th century CE, and that Greek alphabetic numerals were still used in Arabic documents between the 7th and 9th centuries CE (Chrisomalis: 2010). However, in 706 CE, during the Arabization project, Caliph Walid I proscribed the use of Greek for his administrative organisation *diwan* in Damascus, and excluded the use of Greek numerals (Honyman, 1952; Chrisomalis: 2010). The oldest document which uses Abjad numerals is a tax record written on papyrus, which Karabacek dates to the 8th century CE; both Greek and Arabic letters are used to write the numerals (Karabacek, 1894; Ruska, 1917; Cajori, 1928; Chrisomalis, 2010); this document is in the Vienna collection of Egyptian papyri. Although Karabacek places it in the 8th century (Umayyad Period), it is obviously not part of the *diwan*'s Umayyad Arabization project, but an individual attempt to translate Greek alphabetic numerals into Abjad numerals, and may have been produced in the late 8th century, during the Abbasid period. The next known example of Abjad numerals from this collection is from a papyrus dated to the 9th century CE (Karabacek, 1894).

One of the earliest appearances of the term *ḥisab al-Jummal* in Muslim literature can be traced back to Jabir ibn Hayyan's work (c. 721- 815 CE) entitled *kitab al-Aḥjar 'ala Ra'y Balinas* (The Book of Stones according to the opinion of Balinas; Kraus, 1935). Balinas is the Arabized name for the 1st century CE Neopythagorean sage Apollonius of Tyana, and ibn Hayyan mentioned *ḥisab al-Jummal* when referring to Balinas's opinion of the application of *Mizan al-Huruf* (Balance of Letters; Haq, 1994). Furthermore, al-Khwarizmi (c. 780- 850 CE) defined *ḥisab al-Jummal* in his book *Mafatih al-Ulum* (The Keys of the Sciences); he provides a rule for writing numbers as letters in a word. For example, when writing number twelve (*yab*) using this system, the letter with the bigger numerical value is written first on the right (*ya* = 10), then the smaller value on the left (*b* = 2) (al-Khwarizmi, 1989). In *Kitab Ṣurat al-Arḍ* (The Image of the Earth), al-Khwarizmi proposes coordinates for localities in the known world based on Ptolemy's Geography; he has corrected the length of the Mediterranean sea and the location of cities in Asia and Africa (Hosch, 2011), with latitudes and longitudes for all locations, including "cities, mountains, islands, seas and rivers", written in Abjad numerals (al-Ḫuarizmi, 1926). Accordingly, this early evidence leads us to conclude that, during the late 8th century, the motivation to develop Abjad numerals was driven by the translation movement conducted by the Islamic state during the Abbasid period, when translators and scholars sought to replace Greek alphabetic numerals with their own Arabic "Abjad numerals".

There appear to have been three main classifications for using Abjad numerals:

1. magic and divination,
2. interpretation related to religious practices, and
3. literary and scientific

The first two classifications are based on a belief in the mystical properties linking a letter with the number it represents. Ibn Khaldun provides examples from both in the *Muqaddimah.* He discusses how talismans are composed, based on the use of astrology and Abjad numerals, together with the fact that the making of, and belief in, talismans is forbidden in Islam for two reasons; firstly, because they are believed to be harmful, and secondly (and perhaps the most important reason), because they seek help from beings other than God (ibn Khaldun, 1967c). He also mentions *Ḥisab an-nim*, which was used to predict which side would win a war; the decision was based on a numerical evaluation of the names of the warring kings (ibn Khaldun, 1967a; Ifrah, 2000) The second classification includes Islamic sects who used Abjad numerals as a type of science, using the secrets which they believed lay within the letters for their religious interpretations and predictions. Ibn Khaldun devotes a section of his book to the usage of this science by the Sufis, explaining that, in order to determine the letters' secrets, some Sufis divide the Abjad letters into groups according to the Four Elements (that is, Fire, Air, Water and Earth), whilst others use the numerical proportion of the letters based on Abjad numerals as

the relationship between the letters *b, k*, and *r*, where the three letters indicate the number two in each of its different positions (2, 20, 200) or the letters *d, m,* and *t*, which indicate four in its different positions (4, 40, 400), and so on (ibn Khaldun, 1967c). Consequently, they use Abjad numerals to make *awfaq* (magic squares), and in the *za'irajah* (which is a method of finding the answers from questions by determining the connections which exist between the letters of the words used in the question); they imagine these connections can form the basis for knowing what will happen in the future (ibn Khaldun, 1967c). It is done by drawing concentric circles on a piece of paper, then filling many of the subdivisions with letters and numbers (ibn Khaldun, 1967a; Lemay, 1982). On the other hand, Twelver Shias believe the science of the letters' secrets is connected to their book *al-Jafr*, which contains the knowledge of past and future events (al-Qahtani, 2008-2009).

The third category is related to the use of Abjad numerals for literary and scientific purposes; there are a variety of examples as to how they were used in this way:

1. For pagination in book introductions (Chrisomalis: 2010),

2. In administrative records, (as discussed above),

3. In Geography; in al-Khwarizmi's book The Image of the Earth, which recorded latitudes and longitudes for many locations (also mentioned above),

4. In Mathematics; Abjad numerals appear in a copy of the manuscript The Methods of Analysis and Synthesis in Problems of Geometry, dated to the 10th century CE (Ifrah, 2000),

5. In Astronomy; all early Islamic astronomical tables (*zijes)* were written using Abjad numerals (King, 2000), and they were also commonly used for marking gradations on astrolabes (Chrisomalis, 2010).

6. To create chronograms; chronograms are used as a way to write dates (Ifrah, 2000), but this word has a broader meaning which can be classified into four types;

1. the *ta'rikh souri* (explicit dating) which includes the direct mention of dates,
2. the *ta'rikh maʿnawī* (meaningful date) in which the date must be calculated from Abjad numerals (hidden within a phrase or hemistich of a verse),
3. direct and Abjad dates, and
4. *tarikh taʿmīa* where the chronogram is in the form of a riddle (*moʿamma*; Rückert, 1874; de Bruijn, 1991).

With respect to *ta'rikh souri*, research conducted for this study has verified that some chronograms consist of only one word (that is, all the required Abjad numerals are contained within this word). Furthermore, the word itself has no meaning, other than to provide the required year. In most cases, the word used to calculate the date is preceded by the word "year", which indicates to the reader that the date follows next.

Further evidence exists for the chronogram *ta'rikh*, as verified by the following examples from the Islamic world:

6a. To indicate the date of construction of astrolabes; as on an astrolabe which bears the letters *shyh* (300+10+5) to indicate to the year 315 AH/927-928 CE (Ifrah, 2000),

6b. To indicate dates of ancient nations and events in al-Beruni's book a*l-Athar al-Baqiya* (Chronology of the Ancient Nations; originally written in the 11th century; al-Beruni, 1878),

6c. To indicate the year in which coins were minted; the oldest coin which evidences these numerals were minted by Fakhr al-Din Qara Arslan from the Artuqids. The minting year is indicated by *thno* (500 + 50 + 6) 556 AH/1161 CE (Ramadan: 2009),

6d. To indicate the year in which a book was completed, by embedding the year in the title. An example of this appears in the Persian title of Mir Amman's book *Bāgh o bahār* (The Garden and Spring); once calculated, (2+1+1000+6+2+5+1+200) signifies 1217AH/1802-3 CE (Amman, 1857), not 1216 AH as calculated by Schimmel in 1993,

6e. To indicate the dates of important occasions such as births, deaths or weddings, particularly in eastern Islamic countries which use Turkic, Persian or Urdu languages (Farooqi, 2003),

6f. To indicate the construction year of important buildings; it can be embedded in a word, phrase or in the last line of a poem; with a hemistich or more than a hemistich used to calculate the date. When it is found as part of a poem, it is known as a *ta'rikh shi'ri* (poetic chronogram), which can be found either in Arabic poetry books "*diwans*" or as part of the inscription on the façade of Islamic architectures, as attested by the Al-Ain forts. These case studies are from the third type of chronogram, which includes both direct and Abjad dates.

4. AL-AIN FORTS

Al-Ain is located in the eastern region of the Abu Dhabi Emirate in the UAE, close to the western border of the Sultanate of Oman. Al-Ain means spring in Arabic, and refers to the existence of an ancient irrigation system (*falaj pl. Aflaj*) which channeled water from a variety of water sources (such as springs or wells) to the cultivated areas of the oasis. This irrigation system played an important role in its successful agricultural program, especially their prolific date palm plantations. Therefore, protecting the *Aflaj* was extremely important, and was accomplished by constructing defensive architecture; for instance, towers and forts.

In the early 18th century, the political history of southeastern Arabia was influenced by tribal factionalism between tribes belonging to either the Ghafri or Hinawi factions. However, from 1877 as the power of al-Bu Falah, from the Bani Yas tribe, increased in the interior (in the east, and in Al-Ain), they formed alliances with several tribes from the Hinawi group (Potts, 2012). Much of this achievement should be attributed to their ruler Sheikh Zayed bin Khalifa (1855-1909; Potts, 2012) who was described by Miles as "a man of strong character, and perhaps the sole individual in these parts possessing any real personal power and authority" (Miles,1877; Potts, 2012). The following case studies provide evidence of poetic chronogram use from two forts in the UAE; the first was built by Sheikh Zayed bin Khalifa and dated to the late 19th century, and the other was built by his son, Sheikh Sultan bin Zayed, and dated to the early 20th century. Both forts are considered to be antiquities, according to Emirati Antiquities Law (Federal Antiquities Law No. 11, 2017).

4.1. *Al-Jahili Fort*

Al-Jahili Fort is one of the largest in the UAE, and is located in the center of Al-Ain, near the Al-Ain oasis. It was built by Sheikh Zayed bin Khalifa (Zayed the First, who ruled Abu Dhabi between 1855-1909) in the late 19th century.

The complex includes a number of mud brick buildings; a round watchtower, a square fort with three defensive corner towers, two large walled enclosures, and a mosque constructed outside the walls. Sections of a stone-lined subterranean water channel (*falaj*), which ran under the courtyard of the old fort was discovered during restoration and development work in 2008 (Sheehan, 2012; see Fig. 1 below for more detail).

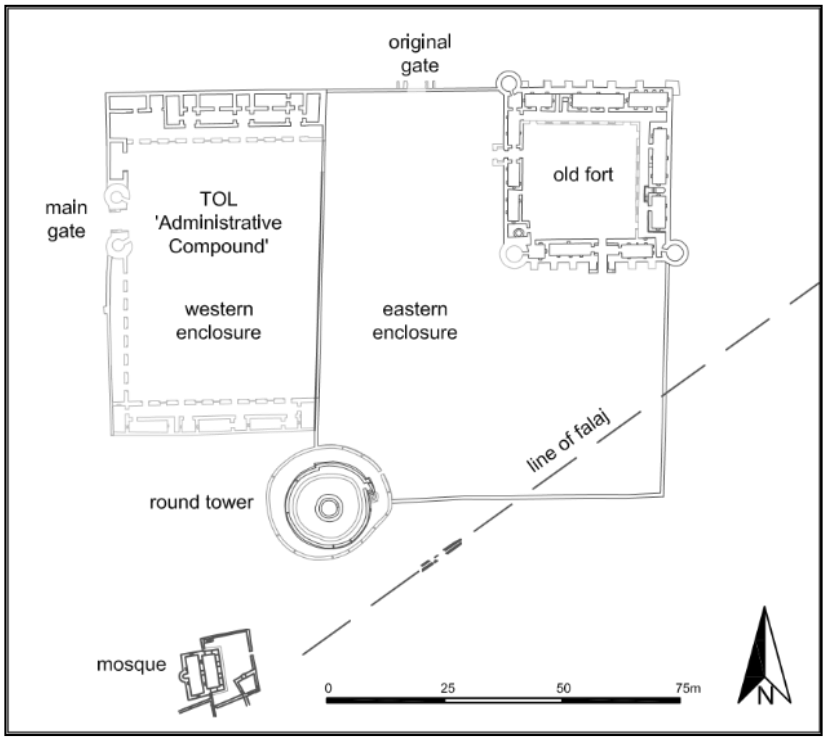

Figure 1: General Site Plan of al-Jahili Fort (Sheehan, 2012)

Based on the archaeological evidence together with old photographs of al-Jahili Fort, three construction phases have been distinguished. The earliest phase includes only the watchtower and the water channel (*falaj*) which was discovered under the courtyard. The second phase is represented by the original construction of the fort, which is located in the northeastern corner of the eastern walled enclosure. The third phase is dated to the period between 1955-1971, when the fort was used as a base for the Trucial Oman Scouts (TOS); it is associated with the construction of a new administrative compound and troop accommodation in the western enclosure (Sheehan, 2012). Sheehan discusses two possible scenarios for dating the earliest phase. The first scenario proposes that the watchtower and the water channel were constructed by the Yaʿaribids in the 18th century, and that the site was later abandoned as a result of raids carried out by the Wahhabis from Najd. In the second phase, according to this scenario, Shaikh Zayed bin Khalifa purchased the site and constructed the fort, and the walled eastern enclosure. The second scenario, which

he tends to favor as more likely to be correct, proposes that al-Jahili was founded by Shaikh Zayed, and that both the first and second phases were conducted during the second half of the nineteenth century. It is important to bear in mind here that the inscription described below, which is carved on a wooden panel over the south main entrance of the old fort, correlates and dates the second phase; that is, when the old fort and the original enclosure were constructed.

The inscription has not been analyzed previously, although the existence of *ḥisab al-Jummal* at the al-Jahili Fort has been mentioned by an earlier scholar (Ali, 2004). The inscription consists of two lines and four hemistiches. The construction date appears in the inscription twice; the easiest to recognize is the numeric Hijri date at the center of the inscription (1316), but the date can be calculated using Abjad numerals in the fourth hemistich of the second line (see Figure 2 below).

Figure 2: The inscription over the south gate of the old al-Jahili Fort (Photo by R. H. Miqdadi)

فتح باب الخير في باب العلا حل فيه السعد بالعلياء المنيفه
فتهاني العز قالت **أرخوا** دار جدّ شاد زايد بن خليفه

English translation
A door of goodness is opened in glory's chapter,
Where joy and happiness with high glory reside,
The blessings of honor said **mark** (**or date** the construction) of this house,
A house of high standing built by Zayed Bin Khalifa
(ADACH, n.d. 1)

As noted above, the date of construction is hidden in the fourth hemistich of the second line, and is preceded by the keyword *'arekho*, which indicates the presence of a hidden date after it. The Arabic imperative verb *'arekho* is a form of the verb *'arakha*, which is translated in a brochure about the al-Jahili Fort as "mark this house" (ADACH, n.d. 1) However, it might be better to translate it as "date the construction of this house", because of its use as a keyword (any form of this word in verb or noun) in most poetic chronograms. The name of the builder, Sheikh Zayed bin Khalifa, is included in the last hemistich of the chronogram. The gemination or doubling of a consonant "*tashdid*" in the word *Jadden,* which means "of high standing", is counted as one letter d = 4. Furthermore, it appears that letters are counted as they are written in Abjad numerals in cases where words end with a "*taa' marbotah*" (T) or "*haa'*" (H). For example, the name Khalifah should have been written as Khalifat (t = 400); however, it was necessary to use Khalifah (h = 5) to obtain the value required to represent the date of construction.

The chronogram can be calculated numerically to equal the Hijri year 1316, which can be seen at the center of the inscription between the hemistitches (see Fig. 2 above), as follows in Table 2:

Table 2: The Chronogram from al-Jahili Fort

خليفه	بن	زايد	شاد	جد	دار
kh+l+y+f+h	b+n	z+a+y+d	sh+a+d	j+d	d+a+r
600+30+10+80+5	2+50	7+1+10+4	300+1+4	3+4	4+1+200
725	52	22	305	7	205
= AH 1316 / 1898-99 CE					

4.2. *The Eastern Fort (Sheikh Sultan bin Zayed Fort)*

Sheikh Sultan bin Zayed Fort, commonly known as the Eastern Fort, lies on the eastern edge of the Al-Ain oasis, adjacent to the Al-Ain National Museum. It was built by Sheikh Sultan bin Zayed in 1910, and was his residence until he became the ruler of Abu Dhabi in 1922. (ADACH, n.d. 2). There is disagreement as to the actual date of construction; some scholars have proposed 1907 (Ali, 2004) while others 1910 (Sheehan, 2012). The later date can now be confirmed as correct, as it corresponds with the date embedded in the inscription on the wooden panel above the south gate, as discussed below.

The fort is square, measuring 35m by 35m, and has rounded towers on each corner, except for the southwest. There is only one gate, in the center of the south wall. The structural elements include a courtyard, four rooms, a kitchen, a well in the northwest area of the courtyard, and a bent entrance (see Figure 3).

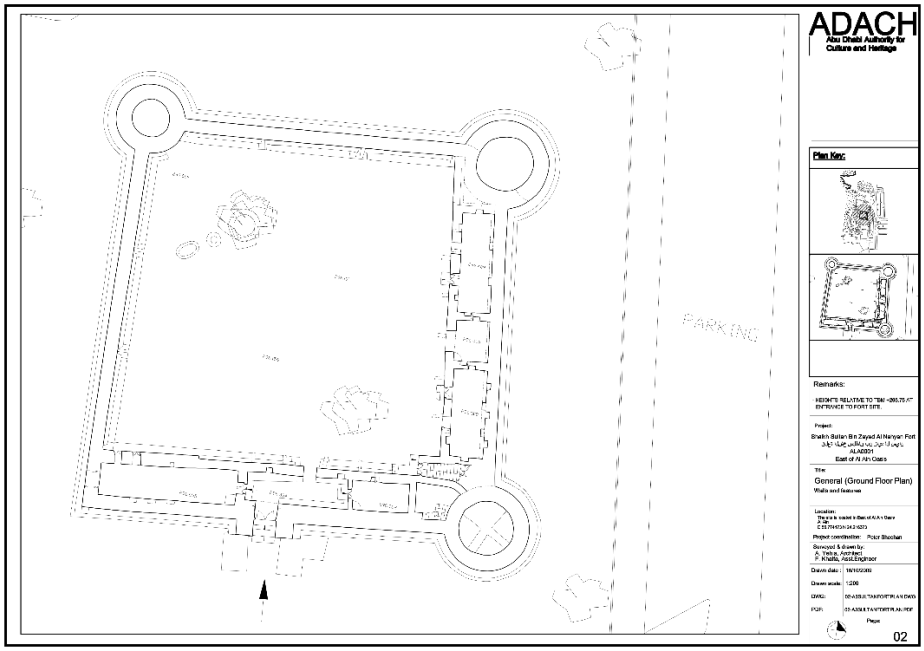

Figure 3: General site plan of the Eastern Fort.
(Peter Sheehan, Historic Buildings Manager at Abu Dhabi Tourism and Culture Authority. Personal communication (email), April 4, 2018)

The inscription consists of two lines and four hemistiches, carved on a wooden panel over the entrance of the fort, similar to that at the old al-Jahili Fort (see Figure 4).

Figure 4: The inscription over the south gate of the Eastern Fort (Photo by R. H. Miqdadi)

لاح نجم السعد في باب العلا مجده باق على ر غم المعاند
أشرق **التاريخ** (باليوم) السعيد شاد بيت الملك سلطان (ابن) زايد

English translation
The star of luck glowed at glory's door
Signifying lasting honor in spite of all adversaries.
History celebrated the happy day
When Sultan (Ibn) Zayed constructed the Kingdom House (ADACH, n.d. 2).

The construction date can be calculated using Abjad numerals located within the underlined words in the third and fourth hemistiches; the keyword *at-tarekho* (which can be translated as history) precedes them, indicating that the reader should start counting the numerical value of the letters following this word. The precise date (20th Sha'ban, 1328) is written at the center of the inscription, as evidenced by the following chronogram in Table 3:

Table 3: The Chronogram from The Eastern Fort

زايد	ابن	سلطان	الملك	بيت	شاد	السعيد	باليوم
z+a+y+d	b+n	s+l+t+a+n	a+l+m+l+k	b+y+t	sh+a+d	a+l+s+ʿ+y+d	b+a+a+l+y+w+m
7+1+10+4	1+2+50	60+30+9+1+50	1+30+40+30+20	2+10+400	300+1+4	1+30+60+70+10+4	2+1+1+30+10+6+40
22	53	150	121	412	305	175	90
= AH 1328 / 1910 CE							

Again, it appears that the letters are counted as they are written in the chronogram. Therefore, *baalywm* (day) is written with two *Alif*s instead of one, in order to obtain the exact construction date. Furthermore, note the spelling for the builder, Sheikh Sultan bin Zayed, which is included in the last hemistich of the chronogram; it is intentionally written as Sultan *ibn* Zayed, rather than Sultan *bin* Zayed, in order to arrive at the total 1328 by counting the numerical value of the Abjad letters. The words *bin* and *ibn* both mean "son of" in Arabic, and the common grammatical rule is to use *bin* as an adjective when it is situated between two names; *ibn* as a predicate is less frequent in occurrence.

4.3. Parallel Examples

The similarity between al-Jahili Fort (the old fort from the second phase) and the Eastern Fort is evident; both have the same general square plan, with three defensive towers. The inscriptions on both forts also share the same characteristics. Firstly, the location of the inscriptions; both are inscribed on wooden panels which surmount the south gate (although, in the case of the Eastern Fort, this is the only gate). Secondly, both inscriptions include the builder's name.

Thirdly, the Hijri date of construction is written both in numbers and by Abjad numerals hidden in a poem, which are preceded by similar keywords *'arekho* (date) and *attarekho* (history). Finally, the two inscriptions bear identical phrases; for example, *bab al 'ula*, which can be translated as "the glory's chapter" at the al-Jahili Fort, and "glory's door" at the Eastern Fort. This leads us to conclude the same chronogramist may have composed both inscriptions, which appears likely, particularly when the fact that only twelve years elapsed between construction of the two forts is taken into consideration.

Al-Sadhan's case study (2008), which was based on reviewing Arab poetry books (*diwans)* in order to determine the construction dates of a building by means of chronograms, provides more than fifty examples related to mosques, schools, public baths, palaces and houses, dated between 940 AH/ 1533-4 CE and 1367 AH/ 1947-8 CE. Again, all of these examples were preceded by the traditional keywords; that is, any form of the verb *arakha* (date; mainly imperative form or past tense, but there is one case which uses present tense) or nouns such as *mo'arekhan*, *ta'rikh,* or *tarikh*, similar to the inscriptions found on the two forts at Al-Ain. It can be noticed from al-Sadhan's study that the earliest examples are from Syria, dated to the 16th century. They include a palace in Aleppo dated to 940 AH/ 1533-4 CE and two examples from Damascus; Mustafa Basha's public bath, dated to 955AH/ 1548-9 CE, and Isma'il al Nabulsi's house, dated to 975 AH/ 1567-8 CE. Although al-Sadhan's examples are only from poetry, they provide an understanding of the distribution of poetic chronograms in the Arab region; further evidence could be found by determining if the buildings which are mentioned still exist, and documenting the poetic chronograms embedded in the inscriptions in situ, if they have survived.

Other parallel examples of construction dates embedded in poetic chronograms within an inscription have been discovered in Jordan, Saudi Arabia, and Egypt. Tütüncü (2013) discusses two such inscriptions which were detected at two forts on the Hajj route; one at Ma'an in Jordan, dated to 971 AH/ 1563 CE and the other at al-Mu'azzam in Saudi Arabia, dated to 1031 AH/ 1622 CE. Despite the fact that these inscriptions are written in Ottoman Turkish and are earlier than those from the Al-Ain forts, there are resemblances to the case studies in this article; they are located above the entrance of the fort, and use the keywords *tarikhi* and *tarikhin* immediately before the Abjad numerals, which Tütüncü translated as date and chronogram respectively.

A study of 154 inscriptions on Islamic buildings in Egypt, all of which can be dated from 600 AH/ 1203 CE - 1312AH/ 1894-5 CE, collected different types of chronogram, using a word, phrase, or hemistich of a poem (Ibrahim, 1994). 87 inscriptions were dated to the timeframe between AH 1111/ 1700 CE and AH 1212/ 1798 CE, which obviously reflects the widespread use of chronograms in general, but particularly in poems, during the 18th century CE. Approximately 40 inscriptions relate to poetic type chronograms; all were preceded by different tense forms of the verb *arakha* (date; mostly imperative form or past tense, seldom in present tense) and the noun *mo'arekhan* (date; as an agent noun) or *tarikh* (history), similar to the keywords on the Al-Ain inscriptions. The earliest examples of this type are recorded from the 17th century, with the exception of one, which is dated to the 14th century; this was discovered on the al-Ma'ini mosque in Damietta, dated to AH 710/ 1310-11 CE (ibid). Despite the importance of this inscription, the limited number of published inscriptions from Arab countries makes it difficult at this stage to determine whether it is the earliest inscription of this type or not. What's more, the small inscribed wooden panel is merely hung on the wall of the building, rather than integrated into the architecture. Thus, it could have been placed here at a later time, to commemorate the builder, and should therefore be considered with caution until further studies, correlating this inscription with the phases of reconstruction or restoration of the mosque, have been conducted. Sometimes, applying specific techniques of Archaeometry is essential to distinguish the old stones from recent parts of the buildings such as Optically-Stimulated Luminescence OSL dating technique (Liritzis, 2020). Finally, after reviewing these inscriptions, it appears that chronograms which appear in a word preceded their appearance in a phrase and in poetry; in these cases, the chronogram was preceded by *sanat* (year) or *fi sanat* (in the year).This type of chronogram by a "word" represents the explicit dating because the word used has no meaning except that it is a group of letters, which are gathered together to give the required total of numerical values equal to the year required. Moreover, this word is preceded by "(w/o in the) year", which is a direct indication for the existence of the chronogram after it. The earliest example of this type of chronogram from Ibrahim's study (1994) is a text on the wall of cemetery (no. 77) from el-Bagawat, which is dated according to the word *raqash* = (200+100+300) to AH 600/1203 CE. "*Raqash*" has no meaning, and was preceded by the word "year" to indicate the chronogram. For example, the chronograms which have been written on astrolabes since the 10th century fall within this classification. Furthermore, this type of chronogram is similar to that found on the Greek inscriptions from Umm el-Jimal in Jordan and Odjeh in Syria; with the chronogram written in the Greek alphabetic numerals and preceded by "in (w/o the) year".

Latin chronograms, which used Roman numerals, have been found in books and inscribed on buildings and monuments to record the date of construction. The earliest examples are dated to the 14th century CE (Hilton, 1882). In Latin chronograms, the Roman numerals are represented by only seven letters (I=1, V=5, X=10, L=50, C=100, D=500, M=1000) (Hilton, 1895). The numerical letters are distinguished from the rest by larger capital letters than the others, or marked with gilding or red paint (Hilton, 1882), while in Arabic poetic chronograms all the letters have numerical values, all letters are counted at the chronogram, and there is also a keyword before the chronogram to indicate that all the letters after it will be counted.

The above mentioned parallel examples from Arab region date the use of poetic chronograms between the 16th and 20th century. Some Persian poetic chronograms extend the commencement date to the 14th century, such as the chronogram which was found on Hafiz of Shiraz's tomb, dated to AH 791/ 1389 CE (de Bruijn, 1991).

5. CONCLUSIONS

The epigraphic evidence from Mesopotamia and its periphery verifies that three separate categories were used for assigning numerical values for some written signs; syllables, words, and total numerical value of syllabic signs. These preceded the invention of the letters – numerals system, which leads us to conclude that the idea of connecting writing signs with numerals originated first in Mesopotamia in the late third millennium BCE. Later, from the 7th century BCE, the name Ionia began to be mentioned in the Mesopotamian inscriptions, recording political and commercial contacts between Mesopotamia and Ionia. Therefore, the idea could have been transferred to Ionia, where Greek alphabetic numerals were invented; the first examples of this system have been dated to the 6th century BCE.

Despite the fact that examples of Greek alphabetic numerals dating from the Hellenistic Period have been discovered in the Near East, the earliest known use of Abjad numerals by Arabs can be dated to the 8th century CE; thus after the advent of Islam. From that time, Abjad numerals have been used for three different purposes. The first category includes magic and divination, which is forbidden in Islam. The second is used by some Islamic sects as part of their religious interpretation practices, while the third comprises a wide range of uses for literary and scientific purposes, ranging from simple pagination to more creative and aesthetic ways of embedding dates in chronograms.

Dates for both the al-Jahili and Eastern Forts in Al-Ain are embedded in a poetic chronogram within the inscription, thus further verifying the features they share with parallel examples which have already been analysed and published; from Jordan, Saudi Arabia and Egypt. The chronogram usually appears in the last line of the poem, most often in the final hemistich, and is preceded by similar keywords which indicate the presence of the hidden date. Any form of the verb *arakha* (date), or words such as *ta'rikh*, *mo'arekhan* (date) or *tarikh* (history), are the indicators for these hidden Hijri dates, which are also sometimes accompanied by an explicit reference to the Hijri year within the same inscription, using numbers; both inscriptions studied in Al-Ain have the two methods of determining the date. Furthermore, other parallel examples from Egypt confirm that chronograms based on a word were used earlier than poetic chronograms, as evidenced by the study of existing Islamic structures which has already been published; they also verify that the use of chronograms, particularly poetic chronograms, became more widespread in the 18th century CE. This study concludes that using Abjad numerals in a chronogram, where a word can be used to determine the construction date, is similar to the explicit dating type which have been found on Greek inscriptions (which use Greek alphabetic numerals) at different archaeological sites, such as Umm el-Jimal in Jordan and Odjeh in Syria, dated to 3rd and 4th centuries CE respectively. On the other hand, poetic chronograms provide meaningful dates which are hidden in the verse, and their earliest appearance dates from the 14th century CE.

In short, the use of Abjad numerals within poetic chronograms has an important historical value, related for the most part to their precise dating for the year of construction, once the information embedded within the inscription has been recognised. This historical value is challenged at the present by the limited number of documented, published inscriptions, which makes it difficult to determine both the earliest example of the use of Abjad numerals in poetic chronograms in the Arab region, and their later development. Furthermore, once the inscriptions have been deciphered, it is still necessary to consider the archaeological aspects; to match existing inscriptions with their correlated phase of construction, reconstruction or even restoration on the site, in order to obtain the maximum accuracy. That is, accurate dating of a chronogram is only possible in relation to the phases of construction.

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REFERENCES

Abu Dhabi Authority for Culture and Heritage ADACH. (n.d. 1) *Al Jahili Fort* [Brochure], Abu Dhabi, Abu Dhabi for Culture and Heritage.

Abu Dhabi Authority for Culture and Heritage ADACH. (n.d. 2) *Eastern Fort* [Brochure], Abu Dhabi, Abu Dhabi for Culture and Heritage.

Ali, A.R. (2004) *Introduction to Architectural and Military Heritage in the United Arab Emirates*, 1st edition, Abu Dhabi, Zayed Center for Heritage and History. (Arabic)

Amman, M. (1857) *Bagh-o-Bahar, or Tales of The Four Darweshes*. D. Forbes. (tr.), London, W.H. Allen & Co.

ibn Arabi, M. (2011) *Al Futuhat Al Makkiyya*, A. Shamsul Din (ed.), Vol. 1. Beirut, Dar Al-Kotob Al-Ilmiyah (Arabic)

Barry, K. (1999) *The Greek Qabalah: Alphabetic Mysticism and Numerology in the Ancient World*, York Beach, Samuel Weiser, Inc.

Bauer, Th. (1996) Arabic Writing. In *The World's Writing Systems*, P. T. Daniels and W. Bright (eds), pp. 559-564, New York/Oxford, Oxford University Press.

al-Beruni, M. (1878) *Al-Athar al-Baqiya ʿan-il-qurun al-Khaliya: Chronologie Orientalischer Völker*, C. Eduard Sachau (ed.), Leipzig, F. A. Brockhaus.

de Bruijn, J. T. P. (1991) Chronograms, *Encyclopedia Iranica*, E. Yarshater (ed.), Vol. V, Fasc. 5, pp. 550-551. Available at http://www.iranicaonline.org/articles/chronograms-pers (Accessed 15 May 2020)

Cajori, F. (1928) *A history of Mathematical Notations*, Vol. 1, Chicago, Open Court Publishing.

Chrisomalis, S. (2003) The Egyptian origin of the Greek alphabetic numerals. *Antiquity*, 77(297):485-496

Chrisomalis, S. (2010) *Numerical Notation: A Comparative History*, New York, Cambridge University Press.

Chrisomalis, S. (2012) Trends and transitions in the history of written numerals. In *The Shape of Script: How and Why Writing Systems Change*, S. D. Houston (ed.), pp. 229-254. Santa Fe, School of American Research Press.

Colles, B. (2014) The Origin of the Alphabet: An Examination of the Goldwasser Hypothesis. *Antiguo Oriente*, Vol. 12, pp. 71-104.

Dalley, S. and Reyes, A.T. (1998) Mesopotamian Contact and Influence in Greek World. 1. To the Persian Conquest. In *The Legacy of Mesopotamia,* S. Dalley (ed.), Oxford/ New York, Oxford University Press, pp. 85-106

Daniels, P. T. (1990) Fundamentals of Grammatology. *Journal of the American Oriental Society*, Vol. 110, No. 4, pp. 727-731.

Delitzsch, F. (1878) Soss, Ner, Sar. *Zeitschrift für Ägyptische Sprache und Altertumskunde*, Vol. 16, Pp. 56-70.

Farooqi, M. A. (2003) The Secret of Letters: Chronograms in Urdu Literary Culture. *Edebiyat*, Vol. 13, No. 2, pp. 147-158.

Federal Antiquities Law No. 11. (2017) UAE. Available at: https://elaws.moj.gov.ae/UAE-MOJ_LC-En/00_CULTURE/UAE-LC-En_2017-06-11_00011_Kait.html?val=EL1 (Accessed 15 May 2020)

Gacek, A. (2001) *The Arabic Manuscript Tradition: A Glossary of Technical Terms and Bibliography*, Leiden/Boston/Köln, Brill.

Gnoli, T. (2002) A Byzantine Greek Inscription from Qasr ar-Rabba (Karak District). *Annual of the Department of Antiquities of Jordan*, Vol. 46, pp. 499-502.

Grayson, A. K. (1991) Assyria 668-635 B.C.: The Reign of Ashurbanipal. In *Cambridge Ancient History: The Assyrian and Babylonian Empires and other States of the Near East, from the Eighth to the Sixth Centuries B.C.,* J. Boardman, I. Edwards, N. Hammond, E. Sollberger, and C. Walker (eds.), Vol. 3, Part 2, 2nd edition, Cambridge, Cambridge University Press, pp. 142-161.

Gruendler, B. (2012) Stability and Change in Arabic Script. In *The Shape of Script: How and Why Writing Systems Change,* S. D. Houston (ed.), Santa Fe, School of American Research Press, pp. 93-118.
Haq, S. N. (1994) *Names, Natures and Things*: *The Alchemists Jabir ibn Ḥayyan and his Kitab al-Aḥjar* (Book of Stones), Dordrecht/Boston/London, Kluwer Academic Publishers.
Hilton, J. (1882) *Chronograms, 5000 and more in number excerpted out of various authors and collected at many places*, London, Elliot Stock.
Hilton, J. (1895) *Chronograms, collected more than 4000 in number since the publication of the two preceding volumes in 1882 and 1885*, London, Elliot Stock.
Honyman, A. M. (1952) The Letter-Order of the Semitic Alphabets in Africa and the Near East. *Journal of the International African Institute*, Vol. 22, No. 2, pp 136-147.
Hosch, W. L. (2011) *The Britannica Guide to Algebra and Trigonometry (Math Explained)*, New York, Britannica Educational Publishing.
al-Ḫuarizmi, M. (1926) *Das Kitab Ṣurat al-Arḍ des Abu Ga'far Muḥammad ibn Musa Al-Ḫuarizmi: Arabischer Text*, H. von Mźik (ed.), Leipzig, Otto Harrassowitz.
Ibrahim, H. (1994) Ḥisab al-Jumal 'ala Ashhar al-Athar al-Islameyya al-Masreyya. *Journal of Arts and Humanities*, Minia University, Egypt, Vol. 12, pp. 1-105 (Arabic)
Ifrah, G. (2000) *The Universal History of Numbers: from Prehistory to the Invention of the Computer,* D. Bellos, E.F. Harding, S. Wood, and I. Monk (trs.). New York, John Wily & Sons, Inc.
al-Isfahani, H. (1992) *al-Tanbih ala Huduth al-Ttashif*, M. Atlas (ed.), 2nd edition, Beirut, Dar Sader. (Arabic)
Juste, D. (2011) Non-transferable Knowledge: Arabic and Hebrew Onomancy into Latin. *Annals of Science*, Vol. 68, No. 4, 517-529.
Karabacek, J. (1894) *Papyrus Erzherzog Rainer: Führerdurch die Ausstellung*, Vienna, Alfred Hölder.
ibn Khaldun (1967a) *The Muqaddimah: An Introduction to History*, F. Rosenthal (Tr.) in three vols, 2nd edition, Vol. 1, New Jersey, Princeton University Press.
ibn Khaldun (1967b) *The Muqaddimah: An Introduction to History*, F. Rosenthal (Tr.) in three vols, 2nd edition, Vol. 2, New Jersey, Princeton University Press.
ibn Khaldun (1967c) *The Muqaddimah: An Introduction to History*, F. Rosenthal (Tr.) in three vols, 2nd edition, Vol. 3, New Jersey, Princeton University Press.
al-Khwarizmi, M. (1989) *Mafatih al Ulum*, I. Al-Ibyari (ed.), 2nd edition, Beirut, Dar Alkitab Alarabi. (Arabic)
King, D. A. (2000) Mathematical Astronomy in Islamic Civilization. In *Astronomy across Cultures: The History of Non-Western Astronomy*, H. Selin (ed.), Dordrecht, Kluwer Academic Publishers, p. 585-613.
Kraus, P. (1935) Jabir ibn Ḥayyan: Essai sur L'Histoire des Idées Scientifiques dans L'Islam, vol. I Textes Choisis, Cairo, Library El-Khandgi.
Landsberger, B. (1915) Der kultische Kalender der Babylonier und Assyrer, Leipzig, J. C. Hinrichs'sche Buchhandlung.
Lemay, R. (1982) Arabic Numerals. In *Dictionary of the Middle Ages*, J. R. Strayer (ed.), Vol. 1, New York, 382-398.
Lieberman, S. (1987) A Mesopotamian Background for the So-Called Aggadic "Measures" of Biblical Hermeneutics? Hebrew Union College Annual, Vol. 58, pp. 157-225.
Liritzis, I., Miller, M. C. and Alappat, L. (2020) The Value of OSL in Distinguishing Ancient from more Recent Structures in an Archaeological Landscape. *Scientific Culture*, Vol. 6, No. 2, pp. 23-34.
Liritzis Y. and Kovachena M. (1992). Evidence for sharp changes in the archaeomagnetic intensity variation during the last 2000 years. *Physics of the Earth and Planetary Interiors* 70, pp. 85-89.
Littmann, E., Magie, D. and Stuart, D. R. (1913) *Greek and Latin Inscription in Syria. Section A, Southern Syria, Part 3: Umm Idj-Djimal*, Leiden, Brill.
Livingstone, A. (1986) Mystical and Mythological Explanatory Works of Assyrian and Babylonian Scholars, Oxford, Clarendon Press
Luckenbill, D. D. (1927) *Ancient Records of Assyria and Babylonia*, Vol. 2. Chicago, University of Chicago Press.
Lyon, D. G. (1883) *Keilschriftexte Sargon's Königs von Assyrien (722–705 v. Chr.)*, Leipzig, J. C. Hinrichs'sche Buchhandlung.
MacDonald, D.B. and Fahd, T. (1997) Sīmiyāʾ. In *Encyclopaedia of Islam*, 2nd Edition, C.E. Bosworth, E. van Donzel, W.P. Heinrichs and G. Lecomte (eds.), Brill, Leiden, pp. 612-613
Miles, S.B. (1877) On the Route between Sohar and el-Bereymi in Oman, with a Note on the Zatt, or Gipsies in Arabia. *Journal of the Royal Asiatic Society of Bengal*, Vol. 46 (1): 41-60.
ibn al-Nadim. (1970) *The Fihrest of al-Nadim: A tenth-Century Survey of Muslim Culture*, B. Dodge (ed. and tr.), Vol. 1. New York and London, Columbia University Press.

Pearce, L. (1982) *Cuneiform Cryptography: Numerical Substitutions for Syllabic and Logographic Signs*, PhD thesis, Yale University.

Pearce, L. (2005) A Late Babylonian Number-Syllabary. In *Literary and Scholastic Texts of the First Millennium B.C*, I. Spar, and W. Lambert (eds.), New York, The Metropolitan Museum of Art, pp. 222-228.

Pongratz-Leisten, B. (2015) *Religion and Ideology in Assyria*. Studies in Ancient Near Eastern Records 6, Boston/Berlin, Walter de Gruyter.

Potts, D. T. (2012) *In the Land of the Emirates: The Archaeology and History of the UAE*, London/Abu Dhabi, Trident Press Ltd/Sultan bin Zayed's Culture and Media Centre.

Prentice, W. K. (1906) Magical Formulae on lintels of the Christian Period in Syria. *American Journal of Archaeology*, Vol. 10, No. 2, pp. 137-150.

al-Qahtani, T. (2008-2009) *Asrar al-hurruf wa hisab Al Jummal*, Master thesis, Umm al-Qura University, Saudi Arabia. (Arabic)

Radner, K. (2005) *Die Macht des Namens: Altorientalische Strategien zur Selbsterhaltung*, SANTAG 8, Wiesbaden, Harrassowitz Verlag.

Ramadan, A. (2009) *Rumuz al-Arqam wa al-taqaweem 'ala al-Nuqud fi al-'Asr al-Islami*, Cairo, Zahraa El-Sharq. (Arabic)

Ratzan, L. (2004) *Understanding Information Systems: What They Do and Why We Need Them*, Chicago, American Library Association

Rölling, W. (1957-1971) Götterzahlen. In Reallexikon der Assyriologie und Vorderasiatischen Archäologie, E. Weidner and W. Von Sodon (eds.), Vol. 3, Berlin/New York, Walter de gruyter, pp. 499-500.

Rückert, F. (1874) *Grammatik, Poetik und Rhetorik der Perser: nach dem siebenten Bande des Heft Kolzum*, W. Pertsch (ed.), Gotha: Friedrich Andreas Perthes

Ruska, J. (1917) *Zur ältesten arabischen Algebra und Rechenkunst*, Heidelberg, Carl Winter's Universitätsbehandlung.

al-Sadhan, M.A. (2008) Dating of Architectural Works Using (Aljommal) Math in the Arabic Poetry. *Journal of King Saud University*, Riyadh, Saudi Arabia, 20 (2), pp. 131-165 (Arabic).

Schott, A. (1938) Wieso bedeutet 15 "rechts" und 2,30 "links"? *Zeitschrift für Assyriologie und verwandete Gebiete,* Vol. 44, pp. 200-205.

Sheehan, P. (2012) In the Interests of the General Peace: The Architectural Development of al-Jahili Fort and its Part within the Policy of Shaikh Zayid Bin Khalifa in al-'Ain. *Liwa: Journal of the National Center for Documentation & Research*, Vol. 4, No. 7, pp. 37-57.

Schimmel, A. (1993) *The Mystery of Numbers*, New York/ Oxford, Oxford University Press.

Solomon, S. (2013) The Classical Arabic Lexicographical Traditions. In *The Oxford Handbook of Arabic Linguistics*, J. Owens (ed.), pp. 520-538.

Trzcionka, S. (2004) *Relating to the Supernatural: A case Study of Fourth-Century Syria and Palestine*, PhD thesis, University of Adelaide, Australia.

Tütüncü, M. (2013) Royal Ottoman Inscriptions on the Istanbul to Mecca Pilgrimage Route (Darb al-Hajj al-Shami). In *The Hajj: Collected Essays*, V. Porter and L. Saif (ed.), London, The British museum, pp. 36-43.

Verdan, S. (2007) Systèmes numéraux en Grèce ancienne: description et mise en perspective historique. CultureMATH 2007, 1-14.