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# PRELIMINARY DATING STUDY OF CLAY TABLET FROM NEO-BABYLONIAN PERIOD

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## ABSTRACT

This work focuses on the archaeometric study of three clay tablet fragments named $BAB_1$, $BAB_2$ and $BAB_3$. One of them, $BAB_1$, probably was manufactured in the Middle East during the Neo-Babylonian period, and contains inscriptions in cuneiform characters. The other two samples $BAB_2$ and $BAB_3$ also contain cuneiform characters, but in incomplete sentences. Typological studies in agreement with historical records suggest that the artifacts were manufactured in the $6^{th}$ century B.C. during the dynasty of Nebuchadnezzar, Great King of Babylon. The age was determined by thermoluminescence (TL) and optically stimulated luminescence (OSL) methods. The annual dose rate for both TL and OSL dating was calculated with uranium, thorium and potassium concentrations determined by instrumental neutron activation analysis (INAA). Additional studies were performed using electron paramagnetic resonance (EPR) to determine the firing temperature, in order to verify if different firing temperatures were associated to different ages. Finally, X-ray diffraction analysis (XRD) was applied to the fragments to verify potential mineralogical differences, indicating different technological choices in the ceramic manufacture (like the choice of clay pastes and firing temperature).

## 1. INTRODUCTION

Ancient cultures and societies with no written history can be traced back by archaeological studies [1]. Before the advent of methods from the fields of physics, chemistry or other sciences, answering questions of “why?”, “how?”, “where?”, and “when?” in studies of the natural and man-made objects involved only classical methods of analysis. There is no doubt that if an artifact is held in hand, its age is of utmost interest. The most classical dating methodology is based on typology [2]. However, typology may reveal which objects belong together, but not their age in a quantitative manner. Answers can be partially obtained if an association is established between the object to be dated and another one of known age.

By whatever means, except in few undoubted cases, such associations remain questionable to a certain extent.

For a long time, several techniques from physics and chemistry have been applied to archaeological studies to answer those questions related with the authentication of pieces of art or objects that are considered cultural heritage of a country. Among the available options, both thermoluminescence dating (TL) and optically stimulated luminescence dating (OSL) as authenticity testing methods are well established and practically are the main techniques applied for artifacts pyrotechnologically manufactured, such as archaeological ceramics.

In this work, three clay tablets probably from neo-Babylonian period were analyzed by X-ray diffraction (XRD), electron paramagnetic resonance (EPR), TL, and OSL with the purpose to study the authenticity of the sample $BAB_1$ and some technological features.

### 1.1 Historical Background of the Sample

The name of Nebuchadnezzar, Great King of Babylon, has never left the mind of historians. The picture of absolute absence of archaeological evidence that would point to his existence changed in the $19^{th}$ century, when cuneiform writings were discovered and deciphered. Had he really existed and constructed a “big city” at least nearly resembling the descriptions of Herodotus, Berosus, or even the Bible, then the ruins of his palaces would be visible in the vicinity areas of modern Baghdad, where ancient Babylon would be located. However, the only vestige currently visible there is an immense desert with a large dusty mound, which the Arabs called *Il Babil*.

Accepting *Il Babil* as the vestiges of ancient Babylon was a difficult task even for the most lenient critics. Many researchers got disappointed when arrived in Baghdad for the first time, and saw only a solitary mountain of bricks (tablets) covered with ancient inscriptions not yet translated. Silence remained the argument of many scholars when it came to discuss the existence of that city mentioned in ancient sources. Furthermore, some of them removed him from history due to the absence of material evidences.

Ernest Renan (1823-1892), one of the main experts in Middle East ancient languages and civilizations from Europe, refused to review Semitic studies based on new archaeological finds and to accept certain declarations from Assyriological studies. He even dissuaded the Louvre Museum from acquiring cuneiform inscriptions found in Nineveh and Tell el Amarna [3].

### 1.2 Nebuchadnezzar’s Evidence in Brazilian Collection

In 2002, the Paulo Bork Archaeology Museum acquired a large piece of terracotta brick from the ancient Babylon site, named $BAB_1$ in this work . The artifact measures 27 x 17 cm and contained three cuneiform lines in almost complete sentences, and their decipherment and translation became a special project of the museum (Picture 1).

**Picture 1: Clay tablet from ancient Babylonian site with cuneiform characters**

The inscription consisted of three parallel lines, read left to right, in neo-Babylonian style (used from 625 – 539 BC). It was a first paleographic indication of the artifact´s age. Its transliteration is

*d.NA3-ku-du2r-ri-URU3 LUGAL KA2.DINGIR.RA.KI [za-nin]*
*E2.SAG.IL2 u3 E2.ZI.DA IBILA [[x]]*
*Sha d.NA3.IBILA.URU3 LUGAL KA2.DINGIR.[RA.KI]*

The assumed translation made originally by Rodrigo Silva, professor of Centro Universitário Adventista de São Paulo, Campus 2, UNASP is:

(I am) Nebuchadnezzar, king of Babylon [provider]
(of the temples) of Esagila and Ezida, first-born son
of Nabopolazzar, king of Babylon.

Those inscriptions are a widely known kind of kingship seal, already found in Babylon and Borsipa. In ancient times, they were located on the walls of the main temples and palaces of the king. The content varies slightly in its context and some of them are displayed at the British Museum, in London [4]. The clay tablet was an ancient form of "royal signature", used by Nebuchadnezzar when erecting various monuments.

The transliteration adopted in this work is based on the *Assyrich-babyloniches Zeichenlist* by Berger [5], which varies only slightly from the Manuel d'Épigraphie akkadienne [6]. Before being presented to the public, that inscription, and its transliteration and translation, was personally verified and edited by several assyriologists, including Everling Janos (editor of the *Babylonian Texts of the First Millennium BC*, and professor at the Universities of Paris and Budapest), Francis Jones (professor of Ancient History at the University of Paris), and Oseas Moura (PhD in Semitic Languages at the Catholic University of Rio de Janeiro). The uppercase letters pertains to Sumerian, and the lowercase ones, to Acadian.

The reference to Esagila and Ezida is also important, as they are the names of the Marduke (Bel) temple, also known as Nebo ("father of culture") in Borsipa. Esagila translates to *house of the elevated tower or house that lifts one´s head*, and Ezida means the *house of peace*. All those terms are very suggestive titles that demonstrate the "pietistic" tone of Babylonian religion.

Esagila stands out in relation to Ezida not only in terms of size, but also due to its dedication to Marduk, the main deity of the Babylonian pantheon. Cattle sacrifices were frequently offered there. The exaggerated Herodotus measurements of Esagila (a square of 354 m side length) can be reduced in, at least, 50%. However, it still remains as a magnificent engineering enterprise, considering the limitations of that period.

The last two symbols on the second line are erased, but it suggests an error made by a scribe, Picture 1. Since the brick is broken on the right side, the inscription´s ending has been reconstructed based on the analysis of other inscriptions, with similar sentence structures. It is possible that the missing piece refers to IBILA A- [sha-re-du], meaning "*exalted firstborn.*"

Regarding the final transliteration, *Na3.Ibila.URU3*, there are no doubts that the name Nabu-apal-uszur is that of Nabopolazzar, the father of Nebuchadnezzar.

It was a Nebuchadnezzar common practice to "sign" the bricks of public buildings with an inscription seal, as a means of perpetuating his name. That aspect of his character agrees with his description in the Bible. The clay tablet found represents an additional evidence for a subject with few preserved historical documents related to.

Being established the archaeological and historical background, it is important to carry out a preliminary dating study using different physical and chemical analytical methods with the purpose to study the authenticity of the clay tablet with cuneiform characters, $BAB_1$.

## 2. ANALYTICAL TECHNIQUES

In this paper, it is presented a general description of the techniques used to study the samples. Details of the each technique are published in several papers and books [2, 7].

### 2.1 X-ray Diffraction (XRD)

X-ray diffraction uses X-rays of known wavelengths to determine the lattice spacing in crystalline structures for the identification of chemical compounds. It is the most widely applied method for structural identification of inorganic materials. Several authors provide a detailed description of the method [8-10]. The sensitivity of the technique depends on the mineral concerned. A well-crystallized mineral for which a particular reflection happens to be strong can be detected at the 1% level, whereas for a poorly crystallized mineral, concentrations in higher than 10% may be necessary.

### 2.2 Electron Paramagnetic Resonance (EPR)

EPR spectroscopy can be used to find the firing temperature of pottery or clay tablet [11-13]. It is based on the absorption of microwave radiation by paramagnetic centers in the ionic crystal. The g-factor of some paramagnetic centers can vary with high annealing temperatures. Such is the case for the signal associated with $Fe^{3+}$, contained in the ceramics.

## 2.3 Thermoluminescence (TL) and Optically Stimulated Luminescence (OSL)

Dating by TL and OSL techniques is a particular application of ionizing dosimetry by crystal luminescence, in which there is a source of constant radiation (natural radioactivity) [14]. The first successful application of luminescence to archaeological material dating was extensively studied by a group at Oxford University, headed by Aitken [14], but it took several more years and considerable research and development for this method to achieve the status of a reliable dating tool [15-18]. The duration of irradiation is taken to be the same as the age of the ceramic, and this is proportional to the amount of the luminescence signal (TL or OSL). Of course, it is essential to have an initial "zeroing of the luminescence signal", this generally being provided by the firing of the ceramic itself: the high temperature reached in the firing process of the object erases the previous luminescence signal by emptying all of the electronic traps. The OSL signal can be also bleached by sunlight exposure during few minutes.

In the case of dating by luminescence (TL or OSL), ceramics can be considered to consist of a number of crystalline inclusions embedded in the ceramic matrix, mainly quartz and feldspar. The inclusions act as dosimeters of the irradiation arising mainly from the natural radioactivity of the ceramic material. The natural radiation responsible for creating the conditions for luminescence has four primary sources: $^{40}K$ and the decay chains of $^{238}U$, $^{232}Th$ and cosmic radiation [19]. This natural radioactivity is the source of the annual dose rate ($D_{an}$) in the ceramics. The age of the pottery can be calculated by the accumulated dose divided by the annual dose rate.

## 2.4 Instrumental Neutron Activation Analysis (INAA)

INAA can be used to determine mainly trace elements in many different matrices, as geological and archaeological materials. In this technique, the samples are submitted to a neutron flux, in order to be activated. A typical thermal neutron source is a nuclear research reactor. Through the induced radioactivity, it is possible to determine the concentrations of elements present in the sample by gamma spectrometry [7].

# 3. EXPERIMENTAL

In this work, three clay tablets found in the vicinity area of Baghdad were analyzed by XRD and EPR. Only the sample $BAB_1$ with cuneiform characters in complete sentences was analyzed by INAA, TL and OSL to verify its authenticity. The clay tablet dimensions were 27 x 17 x 8 cm for $BAB_1$, 9 x 8 x 3 cm for $BAB_2$ and 21 x 13 x 2 cm for $BAB_3$.

Initially, one small piece of approximately 2 x 5 cm in the place with no cuneiform characters was removed from each clay tablet, in order to be analyzed by TL, OSL, EPR, XRD and INAA. This procedure avoided loss of historic information for archaeologists and historians.

For INAA, the side surfaces of the samples were cleaned and drilled to a depth of 2 – 3 mm using a tungsten carbide rotary file, attached to the end of a flexible shaft with variable speed drill. About 3 or 5 holes were drilled as a deep into the core of the shard as possible without drilling through the walls. The powered sample was dried in an oven at $105^{o}$ C for 24 h and stored in a desiccator. About 100 mg of each sample and the reference materials NIST-SRM 1633b, used as standard, and IAEA – Soil 7, used for analytical quality assessment in INAA were weighed into polyethylene bags and wrapped in aluminum foils. The samples and the standards were irradiated at IEA-R1 research reactor for 8 h to determine U, Th and K [20].

For TL and OSL, the same fragments of the original clay tablets were crushed in an agate mortar until a powder was obtained. The powdered material was submitted to chemical treatment in solutions of $H_2O_2$, HCl and HF. The chemical treatment had two purposes: 1) to eliminate, althougt partially, organic and inorganic particles, and 2) partially corrode the surface of quartz grains, such that the effect of α-particles can be neglected [21]. Grains with diameter smaller than 0.088 mm (170 mesh) were used to find U, Th and K content for internal annual dose rate measurements. That powder fraction was also used for XRD and EPR measurements.

### 3.1 XRD

The XRD measurements were performed with a RIGAKU model Miniflex II diffractometer working with Cu-$K_\alpha$ radiation ($\lambda$ = 1.5418 Å) and graphite monochromator in the diffracted beam, at 1.2 kW (30 kV, 15 µA). Spectra were taken in the range 5-80$^o$ 2$\theta$, at 1$^o$ 2 min$^{-1}$(step size = 0.05$^o$ 2$\theta$; time = 1 s). The evaluation of crystalline phases was carried out using Crystallographica Search-Match program developed by Oxford Cryosystems, version 1.1 for use with the International Center for Diffraction Data bank.

### 3.2 EPR

Several papers have already discussed chemical methods used to reduce the intensity of the EPR signal due to $Fe^{3+}$ [11, 22, 23]. This $Fe^{3+}$ signal is usually large and hides the E´-center signal used in EPR dating. In this paper the method proposed by Watanabe *et al*. [21] was used. By an additional chemical treatment with 40% $HNO_3$ solution for 40 minutes, followed by washing with Milli-Q water, it is possible to remove Fe agglomerates by dilution.

For the EPR measurements it was used a Bruker EMX EPR spectrometer operating at X-band frequency with 100 kHz modulation frequency. One hundred milligrams of powdered sample were used for each measurement. Diphenil picryl hydrazyl (DPPH) was used for calibration of the g values of the defect centers.

### 3.3 TL

The TL measurements of the quartz crystal selected from the sample, by chemical treatments [24] were performed using a RisØ TL/OSL reader with a $^{90}Sr/^{90}Y$ β-particle source. TL signals were detected with optical filters Kopp-Corning 7-59 and 3 mm Schott BG-39. SAR protocol was used for equivalent dose determination [25].

### 3.4 OSL

The OSL measurements of the quartz samples were performed using a RisØ TL/OSL reader with a $^{90}Sr/^{90}Y$ β-particle source. The stimulation was done with blue light with wavelength equal to 470 nm and the detection optics used was an optical filter of 7.5 mm Hoya U-340.

### 3.5 INAA

The samples were irradiated at the swimming pool research reactor IEA-R1 of the Nuclear and Energy Research Institute (IPEN-CNEN/SP), at a thermal neutron flux of 1.2 x $10^{12}$ n $cm^{-2}$ $s^{-1}$ for 8 h. Two measurement series were carried out, the radioisotopes $^{42}K$ and $^{239}Np$ to determine K and U, respectively, were measured after 7 days of decay. The radioisotope $^{233}Pa$ was measured to determine Th after 25-30 days of decay, and Th after 25-30 days of decay

[20, 26]. The gamma spectrometry was carried out using a Ge-hyperpure detector, model GX 1925, from CANBERRA with resolution of 1.9 keV at the 1332.05 keV gamma peak of $^{60}Co$. The spectra were collected by a CANBERRA S-100 MCA with 8192 channels. The software Genie-2000 for NAA Processing Procedure, developed by CANBERRA, was used to analyze the gamma-ray spectra.

## 4. RESULTS AND DISCUSSION

The first study was carried out by means of XRD analysis with the purpose to study the mineralogical composition. For this technique, 100 mg of the same powder obtained in the experimental procedure for INAA, were used. Figure 1 shows the diffractograms obtained at room temperature in order to illustrate the mineralogical variation. Table 1 shows the different minerals identified in the diffractograms of the three samples analyzed ($BAB_1$, $BAB_2$, and $BAB_3$).

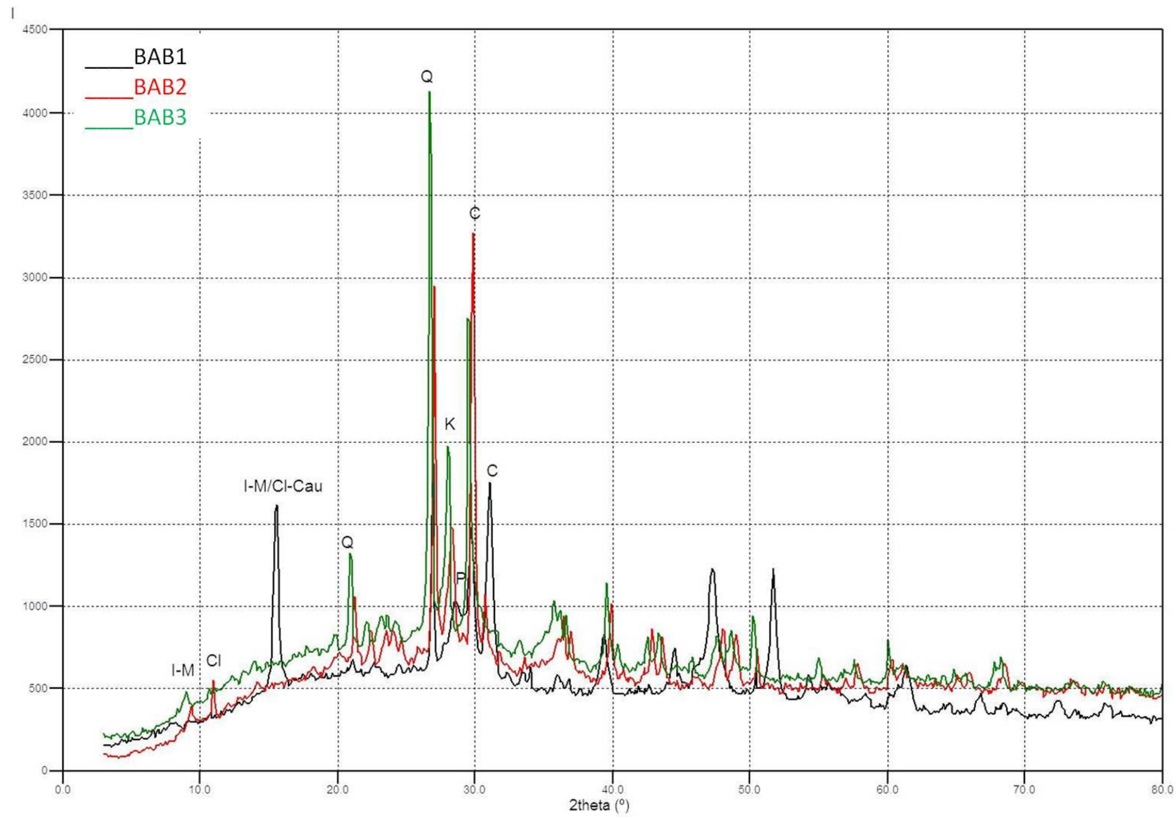



**Figure 1: X-ray diffractogram of the three clay tablet samples, where: Q = quartz, C = calcite, Cl = chlorite, K = K-feldspar, P = plagioclase, I-M/Cl-Cau = illite-muscovite/chlorite-kaolinite.**

As can be seen in Fig 1, a visual comparison of these spectra gives lines with high intensity of quartz. Besides a higher proportion of quartz, the sample contained relatively high amounts of calcite and K-feldspar. The Na and K concentrations found by INAA were 14.0 ± 0.2 and 14.2 ± 0.1 mg $kg^{-1}$, can be accounted for plagioclase and K-feldspar content, respectively. In addition, a peak is observed around 16º that correspond to phyllosilicates illite-muscovite/chlorite-kaolinite.

In a place with restrict availability of wood, fuel baked bricks could be considered a luxury artifact, used only when necessary to protect the unfired bricks from wind and water erosion. There may, however, have been a ritual preference for sun-dried mudbricks in some temple constructions from early times [27]. Several studies show that the Sumerian, Babylonian, Assirian, and Hittite civilizations widely used sun-dried clay tablets for cuneiform inscriptions, which was the written system for most of the languages of the Mesopotamian region throughout the Bronze Age and well into the Iron Age [28, 29].

But it should also be noted that, in the North of Babylon, from where the sample $BAB_1$ comes, timber was more readily available to fire kilns whilst in the south, where fuel was scarce sun-dried bricks had distinct economic advantages. It is remarkable too that walls inscriptions of the Temples in the North shows the preference for the fired kilns technique. The preference for brick (fired or sun-dried) in Babylon is not surprising once good building stone is generally absent.

According to the testimony of Herodotus i. 179 (of Babylon): *"and now I must describe how the soil dug out to make the moat was used, and the method of building the wall. While the digging was going on, the earth that was shoveled out was formed into bricks, which were baked in kilns as soon as sufficient number were made; then using hot bitumen for mortar the workmen began by revetting with brick each side of the moat, and then went on to erect the actual wall."*

In 1968, it was carried out a mineralogical characterization of some clay sources in Iraq [27]. The light fraction consisted mainly of quartz, chert, opal, chlorite, muscovite and calcite. The heavy fraction consisted mainly (more than 80%) of iron ores, epidotes, amphiboles and pyroxenes. Berry [27] reported in 1970 that suspended river sediments from the Euphrates contained smectites (montmorillonites) dominant with chlorite, and some illite and kaolinite.

The presence or absence of mineral clays can guide the identification of an estimated firing temperature range and the firing atmosphere. Often, the microstructural evolution during firing is also dependent on the type of clay, depending on the compositions and impurities [30]. Nevertheless, some general trends can be established. In Table 1, a summary of the mineral phases identified by X-ray diffraction is presented.

K-feldspar was present in the three samples, according to Table 1. Feldspar can be considered a type of inclusion in a ceramic body, commonly associated to mica. These minerals can be found primarily in granites and pegmatites. Feldspars are the primary parent rocks of clay minerals, and can be naturally present in small amounts in clay sources, due to incomplete weathering [26]. Feldspars can be used in the ceramic industry as fluxes, in order to obtain a dense body with reduced porosity. Potash feldspars begin to melt at 1150º C, and soda feldspars at 1118º C. The plagioclases constitute a series of soda feldspars (albite - Na) and calcium feldspars (anorthite) [31].

Illite is a kind of clay mineral. The complete destruction of illite-muscovite is between 950-1000º C. By its presence in samples $BAB_2$ and $BAB_3$, it can be assumed that the firing temperature was below 950º C.

**Table 1: Presence of mineral phases in Babylonian brick samples**

| Mineral phase | $BAB_1$ with cuneiform characters | $BAB_2$ | $BAB_3$ |
|---|---|---|---|
| Smectite | | | |
| Illite-muscovite | | x | x |
| Kaolinite | | | |
| Chlorite | | | |
| Quartz | x | x | x |
| K-feldspar | x | x | x |
| Plagioclase | x | | |
| Calcite | x | x | x |
| Firing temperature range | <850 ºC | <850 ºC | <850 ºC |

x : presence of the mineral

Calcite, present in three samples, is a kind of calcium carbonate that is present in limestone and shells. If lime occurs naturally in clays, the clay is described as calcareous. The presence of calcite in the spectrum indicates that the firing temperature is lower than about 850ºC (low firing temperature), which is the approximate maximum temperature at which calcite may still exist in the ceramic body. When it decomposes, the calcium carbonate forms lime (CaO), and carbon dioxide, according the following reaction [31]:

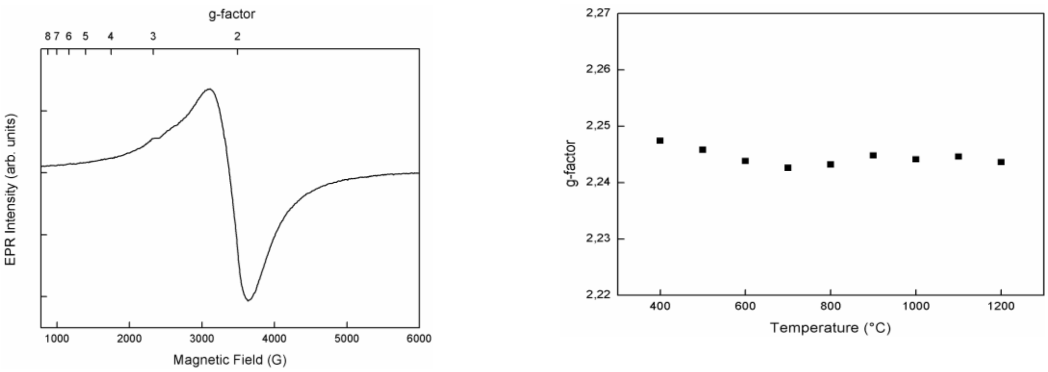
$$CaCO_3 \rightarrow CaO + CO_2\uparrow$$

Above 850º C, the decomposition of calcite can give rise to high-temperature calco-silicates and alumino-calcosilicates, member of the pyroxene group, such as the diopside, plagioclase feldspars (anorthite), gehlenite and wollastonite [32].

In order to confirm the possible absence of firing of the clay tablets, as discussed at the beginning of this section, the $BAB_1$ sample was studied by EPR. Aliquots of this sample were submitted to successive thermal treatment at high temperatures, where the g-value of $Fe^{3+}$ changes [11]. Thermal treatment was performed in a preheated oven in the temperature range from 400 up to 1200° C. Each aliquot was thermally treated for 30 min. Each measurement was carried out with 50 mg of the sample placed inside a quartz tube of 4 mm diameter.

Figure 2a shows the EPR spectrum of the sample resulting from breaking and sieving of the clay tablet. It is observed a broad absorption around g = 2.0; this line is characteristic of $Fe^{3+}$ ion in an octahedral site. Furthermore, these ions are associated with hydrated species of $Fe^{3+}$, which can be oxidized to $Fe_xO_y$ or FeOOH [33]. The EPR spectrum also shows another line in the region of g = 4.3, typical of $Fe^{3+}$ in an orthorhombic site [12, 34, 35].

Figure 2b shows the behavior of the g factor as a function of the temperature for the pottery sample. The g value is practically unchanged in the region of 400-1200° C, indicating that the pottery was not burned in this temperature range. This result may confirm the possibility that the clay tablet from neo-Babylonian period was not burned, and agreed with the XRD results, that showed the firing temperature, if it happened, was below 850° C (Table 2). It is more




a b

**Figure 2: Behavior of g-factor of $Fe^{3+}$ at g=2.0 with heating temperature of the sample $BAB_1$**

difficult to trace the origin of the use of unfired or sun-baked clay products because they leave scarce and poorly recognizable archaeological records. The brick regarding the $BAB_1$ sample was probably used to construct a temple wall, with cuneiform characters in honor of Nebuchadnezzar, as a prestige symbol. The raw materials for the brick production probably involved the use of lime and/or gypsum mixed with water to create a clay paste that harden upon drying.

The OSL and TL measurements were performed also on the sample $BAB_1$ to calculate the equivalent dose $D_e$. In this way, the single aliquot regenerative dose SAR protocol was used [25]. The basic SAR protocol applied to quartz OSL signals is given in Table 2, where the exact measurement conditions can be varied considerably.

**Table 2: SAR protocol applied to quartz signal**

| Step | Treatment |
|---|---|
| 1 | Give dose, Di (=0 Gy if natural signal) |
| 2 | Preheat(160-300°C for 10s) |
| 3 | Optical stimulation for 40 s at 125°C |
| 4 | Fixed test dose, Dt |
| 5 | Cut heat to 160°C (to < preheat in step 2) |
| 6 | Optically stimulated for 40 s at 125°C |
| | Repeat steps 1-6 for a range of regeneration doses bracketing the natural dose. |

Similar results using TL and OSL were obtained, by using the SAR protocol on quartz grains from $BAB_1$ sample, it was calculated the equivalent dose De $\cong$ 5,9 Gy. The annual dose rate was obtained using the Th, U and K concentrations obtained by INAA. The concentrations found were Th = 6.10 ± 0.40 mg $kg^{-1}$, U = 2,27 ± 0.10 mg $kg^{-1}$ and K = 14.2 ± 0.10 mg $g^{-1}$. The analysis of the same elements in the reference material IAEA Soil 7 showed that the accuracy and precision for U, Th and K was less than 6 %. The precision and accuracy level used in this study is in agreement with the criteria recommended [36]. The annual dose rate calculated with this concentration was $D_a = 2.68 \times 10^{-3}$ Gy/year.

By that procedure, using the equivalent dose $D_e$ and the annual dose rate $D_a$, an age of ~ 2207 years was found for the Babylonian brick $BAB_1$. The expected age for the archeological piece is approximately 2700 years. These divergences between the expected and obtained ages probably are due to several factors, mainly i) long time exposition to light (museum) and ii) local heating during the extraction of the sample aliquot to be analyzed by drilling using a tungsten carbide rotary file, which produced a diminution of the stored energy (de-trapped electrons or holes from traps).

## 5. CONCLUSIONS

Three clay tablet fragments, named $BAB_1$, $BAB_2$ and $BAB_3$ from Neo-Babilonian period were studied by five analytical techniques (XRD, EPR, OSL, TL and INAA) with the purpose to assess the authenticity of the sample $BAB_1$ with inscription in cuneiform characters. Regarding XRD, our results showed that the mineralogical composition of the three samples consisted mainly of quartz, K-feldspar and calcite. By the presence of the latter, it was estimated that the firing temperatures, if firing really happened, were lower than 850º C. Only the sample $BAB_1$ has the mineral plagioclase. The EPR study showed that the samples were burned at temperatures lower than 400º C. The clay table regarding $BAB_1$ sample was probably unfired and used to construct a temple wall, with cuneiform characters in honor of Nebuchadnezzar, as a prestige symbol. The OSL and TL studies showed that the age of the sample $BAB_1$ is about 2207 y. However, the expected age is approximately 2700 y**.** This divergence can be related to a new burn caused by a posterior military attack. In fact the Babylonian *Ruin of Esagila Chronicle* (BCHP 6) is one of the historiographical texts from ancient Babylonia that describes in the time of Seleucid Monarchy (268 BCE) an attempt to rebuild the temples of the city that was, according to line 10' IZI ŠUB = *miqitti išâti*, literally "fall of fire". The future complementary studies will be carried out in order to explore the age divergences and further integrating the results from different techniques.

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