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Table of Contents

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A Double Burial from Shahr-I Sokhta Necropolis (Iran). Bioarcheological Investigations and Non-Invasive Biotechnological Studies on Fragments of Human Remains

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Abstract

The archaeological site of Shahr-i Sokhta, in the Sistan region of south-eastern Iran, is noted for the exceptional preservation of human remains documented in its necropolis. This report describes the results of a non-destructive multidisciplinary investigation into a double burial excavated at Shahr-i Sokhta, preserving two skeletons of subadults. The first part of this study provides an archaeotanatological and bioarchaeological description of the burial. Next, we detail the results of the biotechnological techniques applied to bone fragments pertaining to the femurs of the buried children. Following a non-destructive process for studying these samples, we employ a micromolecular technique based on morphological observation using optical, scanning and transmission electron microscopy. This molecular analysis of the bone fragments proves the presence of organic compounds such as tubulin. Through these investigations, we demonstrate that it is possible, utilizing only a few grams of sample, to obtain useful details for scientific research based on non-destructive interdisciplinary investigations.

Keywords

Bioarchaeology, Microanalysis, Human Tubulin, Non-Destructive Analysis, Osteocyte

1. Introduction

Shahr-i Sokhta is located in the Sistan region about 57 km from Zabol. The hot and dry climate, salinity, and gravelly morphology of the site ensure the preservation of organic remains. While today the excavation area is characterized by a desert climate, analysis of the subsoil has reconstructed evidence for some forms of agriculture in the past (Costantini et al., 2007; Sajjadi, 2007). Biotechnological techniques, meanwhile, have provided further and useful information on the archaeological settlement (Biscione, 2010; Milanesi et al., 2016; Milanesi et al., 2019). The methods described in this paper respond to the need to safeguard the subsoil and the precious materials it contains, a goal that has been underserved by the destructive excavation techniques normally employed. The idea of using non-destructive and protective techniques arose from an observation during the 2007 excavation campaign at Shahr-i Sokhta that a series of skeletons that had been recently uncovered incurred rapid damage after being exposed to temperature and brightness. The two child skeletons, which are the object of this study, for example, began to degrade noticeably within a few hours of their removal from the soil. Small bone fragments were secured, and the skeletons were documented photographically. After a few years, we can now demonstrate that even this limited sample of data can provide essential information.

The structural complexity of mineralized tissues is fundamental for understanding the diagenesis of human bones. For instance, osteocytes, often preserved in excavated human remains, can be considered the most numerous lenticular shaped cells in the bone, and are trapped in the calcified matrix within bone cavities. These cells convert mechanical stimuli into internal biochemical signals by means of special cellular components or proteins such as tubulin (Haridy et al., 2021), which act as mechano-sensors (Qin et al., 2020). Microtubules are the main cytoskeletal filaments of eukaryotic cells and participate in the relationship between cell shape, cell division and intracellular transport. The structural genes coding tubulin subunits, namely the α-tubulin and ß-tubulin genes, have received increasing attention in recent decades (Jayaswal et al., 2019), especially for their use as markers to determine the polymorphism of housekeeping genes. In this context, the cytoskeletal apparatus contributes both to the configuration of the cell body of osteocytes and to the peculiar protrusion of primary cilium cells, which is configured as an important sensor coordinating bone homeostasis (Hoey et al., 2012). Environmental factors such as soil pH, soil hydrology and temperature influence the preservation of skeletal tissues. In particular microbial degradation, loss of organics, and mineral changes influence

DNA degradation in mineralized tissues, and multiple diagenetic pathways may act simultaneously on the post-mortem interactions of archaeological skeletal materials (Kendall et al., 2018). The amount of water (waterlogged level) can inhibit diagenetic processes and microbial interaction (Nielsen-Marsh et al., 2000; Lai et al., 2018). Research has highlighted the key role of bacterial communities in the loss of endogenous DNA in some archaeological samples (Rollo et al., 2002). On the other hand, some samples obtained after colonization by bacteria retain their characteristics when subject to fast dehydration, a process responsible for better tissue preservation and useful for amplification and sequencing by PCR (Zaremba-Niedźwiedzka & Andersson, 2013).

This study demonstrates that non-destructive investigations of small quantities of samples can provide a useful basis for archaeotanatological and bioarchaeological studies. In particular, with just a few fragments of a human biological sample, it is possible to conduct micromolecular studies aimed at investigating the morphological and chemical content of cellular residues and the potential evidence of tubulin in archaeological bone tissue.

2. Archaeological Contextualization

Shahr-i Sokhta is a large archaeological site measuring 150 ha (Sajjadi et al., 2003) and located in Iran near the borders with Pakistan and Afghanistan. Several years of archaeological investigations have uncovered a funerary area extending over 20 ha. So far, 1200 tombs have been documented in this area (Biscione et al., 1977; Sajjadi et al., 2008). The 2007 excavation campaign revealed a well-preserved burial (number 8116, square NFH) consisting of two subadult skeletons accompanied by two jars and a bowl (**Figure 1**). The recent analysis of

Figure 1. Samples taken from the compact bones of the children's femur (Circle-point; left = SX and right = DX) from the grave 8116 of the NFH square at Shahr-i Sokhta.

Ascalone (2022) has revised the chronological sequence of Shahr-i Sokhta, including the original dating of the burial to 2200 BCE proposed by Salvatori and Tosi (2005).

3. Methods and Material

3.1. Archaeothanatology and Bioarchaeology

The archaeothanatological approach of this study follows the approach of Duday (2009) and Harris and Tayles (2012). Determinations of the sex and age of the skeletons are made according to Byers (2022) and Buikstra and Ubelaker (1994). Estimations of stature, meanwhile, are calculated according to Sjøvold (1990).

3.2. Sampling

The two fossil skeletons were found in grave 8116 (square NFH) of the large necropolis located at 30˚39'63"N; 61˚23'59.9"E on a plateau about 55 km SW of Zabol in SE Iran (**Figure 2** circle-point). Excavation of the skeletons began with the removal of a first surface layer, followed by a second layer of agglomerated gravel preserving the samples in an anaerobic environment. To prevent contamination of the remains, the excavation team donned sterile gloves and masks, removing the samples within a few minutes of their unearthing. Two fossilized

Figure 2. The archaeological site of Shahr-i Sokhta, Sistan, Iran (30˚39'N; 61˚24'E) lies on a Plio-Pleistocene plateau lies about 55 Km SW of Zabol in SE Iran (Circle-point).

femur fragments measuring a few centimetres were acquired (Figure 1 circle-point). These samples were quickly deposited in a sterile Falcon capsule and stored under aseptic conditions at room temperature.

3.3. Transmission Electron Microscopy

Next, the bones were prepared for ultrastructural observations. Fragments were fixated in 3% glutaraldehyde and 1% osmium tetroxide for 30 minutes, then gradually dehydrated at room temperature in anhydrous ethanol mixed with decreasing amounts of water (40%, 60%, 80%, and 100%) infiltrated with Spurr epoxy resin, then cured at 70˚C for 7 hours in an oven. Thin sections of the polymerized samples were cut using an LKB III Ultrotome microtome with a diamond blade and examined using a Zeiss Axiophot 400 optical microscope. The ultra-thin sections were collected on copper grids, stained for 3 minutes in 2% uranyl acetate and 2% lead citrate, and subsequently observed using a Philips Morgagni 268D transmission electron microscope (TEM).

3.4. Scanning Electron Microscopy and X-Ray Microanalysis

A sample of bone fragments was coated with graphite (Edwards Scancoat S150A) and observed under a scanning electron microscope (Philips XL20). To determine the chemical elements, the instrument was equipped with an X-ray microanalysis probe, which was used at an acceleration voltage of 20 kV. The concentration of chemical elements on the bones was determined with an error of about 1%. The mean concentrations and standard deviations of each element were measured at five different points in the samples. The X-ray beam was 1 μm wide and penetrated to a depth of 2 μm.

3.5. DNA Isolation from Fossil Human Skeletons and PCR Conditions

70 mg of bone samples from each skeleton were used to extract DNA. DNA was isolated by use of a commercial kit, the GeneElute Mammalian mini prep kit (Sigma Aldrich). Minor modifications were made to minimise the presence of PCR inhibitors that are often present in fossil bones (Rohland & Hofreiter, 2007). The samples were homogenised in a small ceramic mortar 5 cm in diameter. Total DNA was resuspended in 30 microliters of elution buffer provided by the kit. All steps were performed at room temperature (about 20˚C), thereby reducing further degradation of the ancient DNA. The PCR amplification was performed in two-sequential steps under a sterile biohazard laminar flow. The first PCR reaction consisted of a total volume of 12.5 μl containing: 2.5 μl DNA, 0.25 mM of dNTPs, 0.25 μM of each primer, 1× Green GoTaq Reaction buffer containing 1.5 mM MgCl2, 0.1 U of Taq DNA Polymerase (Promega). The first PCR amplification step was performed according to the following cycle scheme: 95˚C for 5 minutes, 39 cycles at: (94˚C for 30 seconds, 60˚C for 30 seconds, and 72˚C for 1 minute), 72˚C for 10 minutes. Primers were synthesized to amplify

small sections of the highly conserved ß-TUB genes. The Forward primer sequence is: AGGGATAGAACGGCTTGAATGG, while the Reverse is: TAGGAGTGCTGAGTTTGAGAGTGC. A second PCR step using the same conditions was conducted using 5 microliters of the amplicon obtained after the first amplification step and increasing the PCR mixture proportionally to a final volume of 50 microliters. The PCR products were checked with standard 1% agarose gel in TAE buffer. The DNA on gel was stained with FluoroVue (Smobio) dye in agreement with the manufacturer's instructions.

4. Results and Discussion

4.1. Archaeothanatology

The double burial consisted of an inhumation grave holding two children (Figure 1).

The body (A) observed on the right of Figure 3 was probably deposited first, followed by the body on the left (B). This depositional hypothesis is suggested by the right femur of A, broken about mid-diaphysis, possibly indicating that it was superimposed on the right tibia of B. Due to the limitations of the existing photographic documentation, however, it cannot be excluded that the femur passed under the tibia. On the basis of the close anatomical resemblance of the two subjects, it can be hypothesized that the inhumations and therefore the deaths of both subjects were contemporary, with the deceased deposited and covered immediately. The absence of earth between the skeletons further strengthens this hypothesis. Both skeletons lie on their side (right side A and left side B) with the upper limbs hyperflexed (171˚A, 168˚B), the hands folded in front of the face, and the lower limbs flexed (50˚A, 23˚B). Previous excavation campaigns in Shahr-i Sokhta have documented the remains of clothing and reed mats or baskets

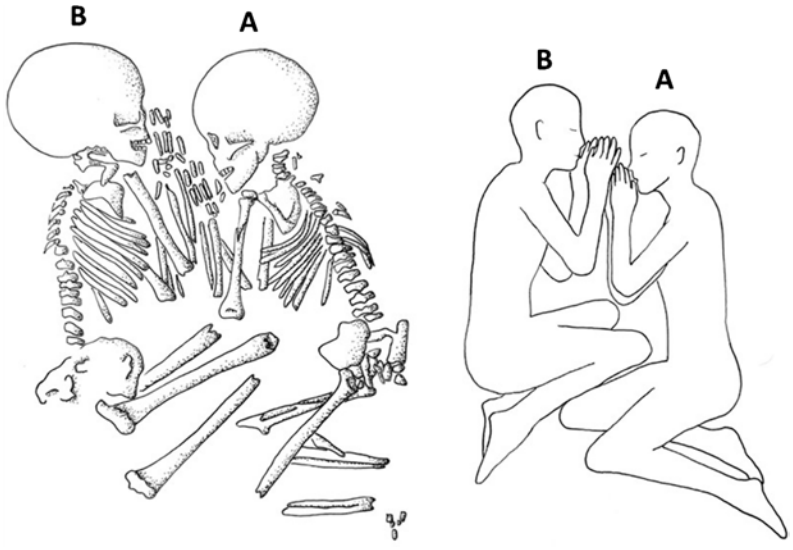

Figure 3. Plan of the double inhumation of children (left) and reconstruction of arrangement of the deceased in the grave (right). A shows the body buried as first and B as second.

together with lace beads found near the cervical spine (Piperno & Salvatori, 2007; Sajjadi et al., 2003), thus suggesting that it was customary to dress the deceased at the time of burial. Organic materials such as mats and clothes are in some cases shown to have dissolved before the soft tissues of the subjects they adorned (Harris & Tayles, 2012), even if traces remain. In the tomb of the two children, however, no traces of clothing were found, and it is plausible that the individuals were buried without clothing. Their high level of preservation is due to the surrounding sediment matrix consisting of very fine-grained soil which implemented a progressive replacement of the soft tissue.

4.2. Bioarchaeology

Judging from the photos taken with metric scales, the teeth conserved in the dental socket of the superior and lower dental arcades suggest an age at death between 6 ± 24 months for both individuals. Namely, the maximum length of the long bones of subject A, with a maximum length of the left humerus of 197 mm, corresponds to an age of 8 - 10. Subject B, with a maximum femoral length of mm 244, was aged 6 - 9 years old (Stloukal & Hanakosa, 1978). No evidence of pathological modifications was observed on the bone remains of children.

4.3. Micromolecular Morphology

The bones contain fibres providing elasticity and minerals that ensure compactness. The main proteins and minerals were deposited by the secretory activity of osteocytes. These latter cells are abundant in bone and serve as the main regulators of bone homeostasis through calcium modulation. They also act as main responses to external mechanical stimuli that induce signalling pathways involved in osteocytes (Qin et al., 2020). The TEM study performed on the samples showed different ultrastructures. The left skeletal bone appeared well preserved with numerous compact fibres (**Figure 4(A)**). In contrast, the right skeleton showed numerous fibres with a less dense structure (**Figure 4(C)**). Morphological analysis carried out via scanning electron microscopy (SEM) of the left skeleton showed a well-preserved structure with the presence of some *canalicula* (**Figure 4(B)**), while the right skeleton appeared to have deteriorated and poorly preserved (**Figure 4(D)**). Human bone is only one of several vertebrate collagenous tissues that are strengthened and hardened *in vivo* by the precipitation of poorly soluble inorganic minerals. Human femur bone has approximately 26 wt% organic matter, 9 wt% - 10 wt% water and 64 wt% mineral fractions (Zioupos et al., 2000). The chemical composition of the fossilized bones was evaluated by SEM-EDAX microanalysis (**Figure 5**). Phosphorus (P) is an essential element of the mineralized bone component and homeostasis appears to be controlled by osteocytes which play an active role in bone mineralization and phosphate regulation (Feng et al., 2009). Phosphorus (P) was detected in both samples but was more abundant in the left skeleton. Calcium (Ca), which plays an essential role in bone firmness (Bonjour, 2013), was contained in similar quantities in the two samples.

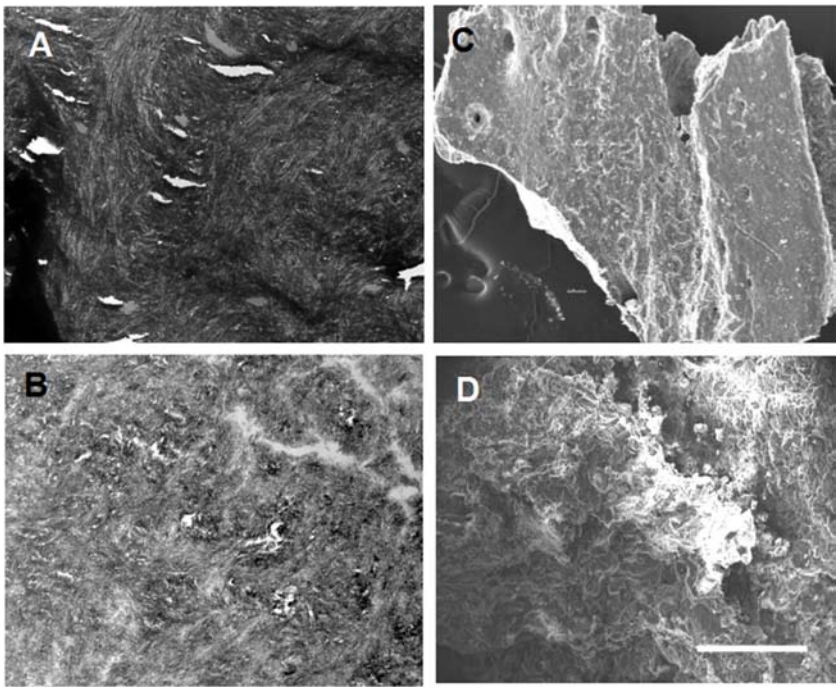

Figure 4. TEM morphology observation of samples a well preserved archaeological left skeleton with numerous details (A) and the right skeleton showing a large quantity of fibres although less electrondense (B); Bar = 5 μm. SEM morphological observation of the archaeological left skeleton with well preserved osteocytes (C) and the archaeological right skeleton deteriorated and poorly preserved (D); Bar = 500 μm.

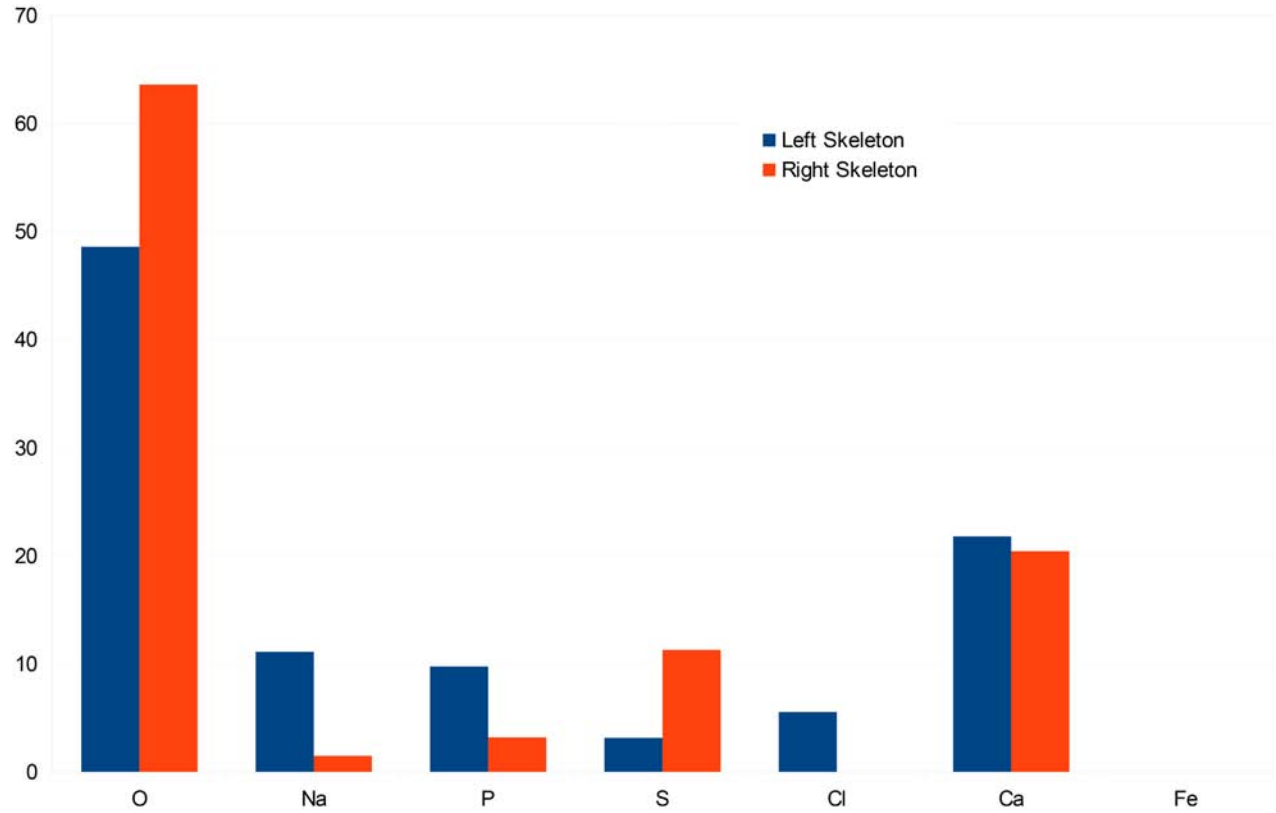

Figure 5. Microanalysis shows the chemical composition of the minerals on the surface level of the femurs fragment.

In the necropolis of Shahr-i Sokhta, after bones found under aerobic conditions are unearthed, the skeletons disintegrate and disappear after a few days, confirming the crucial role of deteriogenic oxygen (O), (Surabian, 2012). This compound is contained in greater quantities in the right sample, which displays a deficiency of Sodium (Na), Phosphorus (P), the absence of Chlorine (Cl) and an abundance of sulphur (S). In the left skeleton, oxygen was detected in a smaller quantity, while we observed the presence of Na, P and Cl and a deficiency of S. This could confirm the quality of the left skeleton's preservation.

4.4. Micromolecular DNA Study

The DNA study was performed on the femurs in an attempt to understand the nomadism or sedentarism of the settlement's inhabitants. During the excavation, local authorities permitted the acquisition of only a small sample quantity. However, once placed in aerobic conditions, the skeletons quickly became deteriorated and volatilized. Despite the small available sample size, it was decided to prepare a test for investigating the presence of tubulin in the bones. In human subjects, the temporal bone is known to have a high degree of mineralisation, and this is likely due to high levels of protein and endogenous DNA that can survive in archaeological specimens compared to non-petrous skeletal elements (Gamba et al., 2014; Jørkov et al., 2009). Like other archaeological bone fragments, our samples taken relating to human femurs showed the presence of biomolecules such as DNA. Agarose gel analysis of the PCR products revealed amplicons of 140 bp after the second round of amplification (**Figure 6**). DNA sequencing results were obtained only for PCR products derived from the left

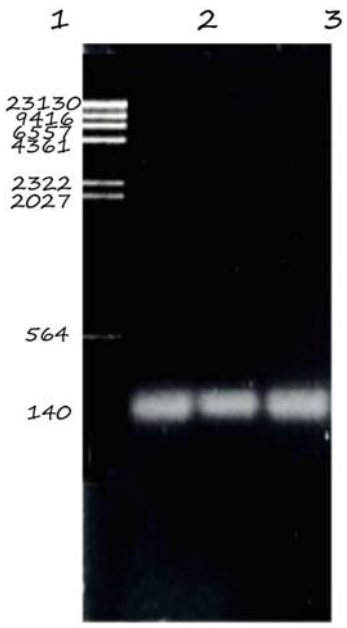

Figure 6. Analysis by agarose gel of 140 bp PCR products obtained from human skeletons. From left: 1) Lambda/Hind III [250 ng]; 2) Human archaeological skeleton on the right; 3) Human archaeological skeleton on the left.

skeleton. We found low amounts of nucleic acids in the right skeleton. Osteocytes found in archaeological bones may contain a significant trace of nucleic acids and the α-tubulin and ß-tubulin genes are considered the main cytoskeletal markers of eukaryotic cells, especially for the purpose of determining the presence of particular housekeeping genes and assessing the changes occurring in DNA traits with which they are associated. CLUSTAL W direct comparison of the left skeletal PCR products (**Figure 7**) targeting the ß gene-TUB revealed a significant correspondence with the 3'-prime end of the *Homo sapiens* tubulin beta 4B class IVb (TUBB4B), mRNA (Jayaswal et al., 2019). In particular, amplicons detected the 3-prime end of the untranslated mRNA which was enriched with several untranslated sequences. Conserved non-coding elements (CNEs) show an extraordinary degree of conservation between species and are distributed in a non-random way on chromosomes which tend to cluster near genes with regulatory roles in cell development. Vertebrate genomes contain thousands

```
CLUSTAL O(1.2.4) multiple sequence alignment

NM_006088.6     AGCACTCTGCGCGCCCGCTCTTCTGCTGCTGTTTGTCTACTTCCTCCTGCTTCCCCGCCG   60
SK              ------------------------------------------------------------   0

NM_006088.6     CCGCCGCCGCCATCATGAGGGAAATCGTGCACTTGCAGGCCGGGCAGTGCGGCAACCAAA   120
SK              ------------------------------------------------------------   0

NM_006088.6     TCGGCGCCAAGTTTTGGGAGGTGATCAGCGATGAGCACGGCATCGACCCCACGGGCACCT   180
SK              ------------------------------------------------------------   0

NM_006088.6     ACCACGGGGACAGCGACCTGCAGCTGGAACGCATCAACGTGTACTACAATGAGGCCACCG   240
SK              ------------------------------------------------------------   0

NM_006088.6     GCGGCAAGTACGTGCCCCGCGCCGTGCTCGTGGATCTGGAGCCCGGCACCATGGACTCCG   300
SK              ------------------------------------------------------------   0

NM_006088.6     TGCGCTCGGGGCCCTTCGGGCAGATCTTCCGGCCGGACAACTTCGTTTTCGGTCAGAGTG   360
SK              ------------------------------------------------------------   0

NM_006088.6     GTGCTGGGAACAACTGGGCCAAGGGGCACTACACAGAAGGCGCGGAGCTGGTGGACTCGG   420
SK              ------------------------------------------------------------   0

NM_006088.6     TGCTGGATGTTGTGAGAAAGGAGGCTGAGAGCTGTGACTGCCTGCAGGGTTTCCAGCTGA   480
SK              ------------------------------------------------------------   0

NM_006088.6     CCCACTCCCTGGGTGGGGGGACTGGGTCTGGGATGGGTACCCTCCTCATCAGCAAGATCC   540
SK              ------------------------------------------------------------   0

NM_006088.6     GGGAGGAGTACCCAGACAGGATCATGAACACGTTTAGTGTGGTGCCTTCGCCCAAAGTGT   600
SK              ------------------------------------------------------------   0

NM_006088.6     CAGACACAGTGGTGGAGCCCTACAACGCCACCCTCTCAGTCCACCAGCTCGTAGAAAACA   660
SK              ------------------------------------------------------------   0

NM_006088.6     CAGACGAGACCTACTGCATTGATAACGAAGCTCTCTACGACATTTGCTTCAGAACCCTAA   720
SK              ------------------------------------------------------------   0

NM_006088.6     AGCTGACCACGCCCACCTATGGTGACCTGAACCACCTGGTGTCTGCTACCATGAGTGGGG   780
SK              ------------------------------------------------------------   0

NM_006088.6     TCACCACCTGCCTGCGCTTCCCAGGCCAGCTCAATGCTGACCTGCGGAAGCTGGCTGTGA   840
SK              ------------------------------------------------------------   0
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NM_006088.6     ACATGGTCCCGTTTCCCCGGCTGCACTTCTTCATGCCCGGCTTTGCCCCACTGACCAGCC   900
SK              ------------------------------------------------------------   0

NM_006088.6     GGGGCAGCCAGCAGTACCGGGCGCTGACCGTGCCCGAGCTCACCCAGCAGATGTTTGATG   960
SK              ------------------------------------------------------------   0

NM_006088.6     CCAAGAACATGATGGCTGCCTGCGACCCCCGCCATGGCCGCTACCTGACGGTTGCCGCCG   1020
SK              ------------------------------------------------------------   0

NM_006088.6     TGTTCAGGGGCCGCATGTCCATGAAGGAGGTGGATGAGCAAATGCTTAATGTCCAAAACA   1080
SK              ------------------------------------------------------------   0

NM_006088.6     AAAACAGCAGCTATTTTGTTGAGTGGATCCCCAACAATGTGAAAACGGCTGTCTGTGACA   1140
SK              ------------------------------------------------------------   0

NM_006088.6     TCCCACCTCGGGGGCTAAAAATGTCCGCCACCTTCATTGGCAACAGCACGGCCATCCAGG   1200
SK              ------------------------------------------------------------   0

NM_006088.6     AGCTGTTCAAGCGCATCTCCGAGCAGTTCACGGCCATGTTCCGGCGCAAGGCCTTCCTGC   1260
SK              ------------------------------------------------------------   0

NM_006088.6     ACTGGTACACGGGCGAGGGCATGGACGAGATGGAGTTCACCGAGGCCGAGAGCAACATGA   1320
SK              ------------------------------------------------------------   0

NM_006088.6     ATGACCTGGTGTCCGAGTACCAGCAGTACCAGGATGCCACAGCCGAGGAGGAGGGCGAGT   1380
SK              ----------------------------------------------------AAGGGGGGT   9
                                                                    * ** * **

NM_006088.6     TCGAGGAGGAGGCTGAGGAGGAGGTGGCCTAGAGCCTTCAGTCACTGGGGAAAGCAGGGA   1440
SK              TTGGGCGGGC-------------ATATGTTAGTAGGGTGTATGAGCCAGTATACAACCGG   56
                * * *  **               *    ***     *   * *    * * *  *  *

NM_006088.6     AGCAGTGTGAACTCTTTATTCACTCCCAGCCTGTCCTGTGGCCTGTCCCACTGTGTGCAC   1500
SK              ACCGGTGATAGCTACATAGAGCCATAA---AGGCCTTGTGATCTTTG----------CTA   103
                * * ***  * **   **    *         * * ****  ** *          *

NM_006088.6     TTGCTGTTTTCCCTGTCCACATCCATGCTGTACAGACACCACCATTAAAGCATTTTCATA   1560
SK              ATTTTTTATGCACTCTCAAACTCAGCCCTCCTAAAAAA----------------------   141
                 *  * * * * ** ** *  **    **    * * *

NM_006088.6     GTG    1563
SK              ---    141
```

Figure 7. Clustal W of the sequence of the PCR product obtained from the left archaeological skeleton aligned with the *Homo sapiens* tubulin beta 4B class IVb (TUBB4B), mRNA Beta-TUB. A significant match was found at the 3'-prime end of the sequence, as shown by the asterisks.

of conserved non-coding elements that often function as tissue-specific enhancers (Alison et al., 2011). The selection acting on the enhancer sequences is mainly responsible for the retention of these regions, which may be associated with a physicochemical stability of the CNE motifs among the taxa (Hezroni et al., 2017). Finally, some factors, including DNA quality and amplification efficiency, could interfere and affect the accuracy and reliability of the results obtained. Therefore, genes such as tubulin that constantly maintain their gene expression and, therefore, their basic functions should guarantee the accuracy of the experimental results obtained (Arya et al., 2017; Nagy et al., 2017). Furthermore, the development of a protocol that works on ancient biological material to obtain information on the conservation of DNA sequences during evolution may be suggested, helping to formulate hypotheses of a phylogenetic nature (Shi et al., 2016).

5. Conclusion

In archaeological excavation, greater attention should be paid to the conservation of organic finds, which are quickly destroyed by oxidation once uncovered. In this study, we have attempted to unite interdisciplinary approaches aimed at safeguarding these precious finds. Through an archaeothanatological and bioarchaeological investigation of the remains and a micromolecular morphology and DNA study of the few fragments of bone tissue collected, we have offered a few hypotheses. Archaeothanatology investigations suggest that the body on the right was placed first due to the overlap of the lower limbs. Furthermore, the children were buried without clothing as they lay on the ground wrapped in very fine powdered inorganic material, stabilizing the bone remains. The teeth preserved in the sockets of the upper and lower dental arches and the length of the long bones suggest an age of about 6.5 years for subject A and about 7 years for subject B. No evidence of pathological changes was observed. Electron microscopy and microanalysis of the bone fragments confirmed the poor preservation state of the right skeleton and, conversely, the good state of conservation of the left skeleton. The latter showed numerous ultrastructural details, including fibres and chemical elements such as Ca, Na, P, Cl and S essential for bone homeostasis. Furthermore, in line with its better state of preservation, the deteriogenic element O was found in less quantity for the left skeleton. Finally, the results of the molecular analysis confirm the presence of amplifiable tubulin in the remains of the left skeleton. The discovery of the *homo sapiens* beta tubulin gene fragment could be useful in the future for further phylogenetic studies. This preliminary interdisciplinary investigation confirms that even a fragment of fossil bone may contain useful information and in-depth studies of small samples can reveal details about the mystery of past life in the future.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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The Role of Abolishing Gravity in Ancient Egyptian Pyramids Architecture

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Abstract

The pyramids are one of the most important signs and witnesses of pharaonic architecture which they reflect the accuracy and craftsmanship of the Egyptians' ancient ancestors. Historians relied on prognostication in explaining the construction methods and finding indicators that document this prognostication. In this research, it is believed that the use of primitive methods of lifting and pushing blocks is not commensurate with the genius and skill of workmanship of the way the pyramids were constructed as these methods are scientifically poor and measured in the current simple concept. Hence, it is necessary to search for unconventional building and stone lifting techniques that were compatible with the status of the ancient Egyptians and their scientific progress. This has always been the stimulus to look for the brilliance and simplicity of the pyramids' structures at the same time. The starting point is that pushing stone blocks required extraordinary effort which is practically illogical. Firstly, according to the traditional theories that have so far discussed the construction of the pyramids, masses were supposed to be pushed on a slope with distances exceeding hundreds of meters. Secondly, this article examines a suggested method of the ancient Egyptians' use the means of abolishing the Earth's gravity to move and lift blocks with ease from the perspective of the theory of Acoustic Lifting. Thirdly, this article suggests another method that could have stood behind the ability to move the pyramids' huge stones to place them in their right positions which is Water Lifting and using the Nawamis with reference to a well-studied model according to Pascal's law.

Keywords

Egyptians, Pyramids, Traditional Theories, Acoustic Lifting, Water Lifting, Nawamis

1. Introduction

The pyramids that date back to thousands of years ago and the Egyptian civilization are highly interrelated. The pyramids are the destination of almost every tourist to the Middle East in general and Egypt in specific. Their strong influence on the culture and art of Egypt cannot be ignored which highly refers to their considerable presence in the life of Egypt, the neighboring countries and civilizations during all these years. The pyramids were built from huge stones that were transported from Aswan region, south of Cairo, through the Nile River to the pyramids area. The Greek historian Herodotus (484-420 BC) mentioned the Great Pyramid and the era of the Pharaoh of Egypt (Khufu) in paragraphs (141, 142, 124, 129) of the second part of his history book devoted to Egypt (Herodotus & Godley, 2018). Herodotus stated that the construction and preparation of a single pyramid took tens of years. It was a very long time that took many workers.

1.1. A discussion of a Previous Study

The latest study that has discussed the abolition of gravity for the construction of the pyramids is by Nick Redfern in his book, 'How Antigravity Built the Pyramids: The Mysterious Technology of Ancient Superstructures'. In his book, Redfern discusses the idea of building the pyramids by using sound. The whole hypothesis of gravity abolition is based on a mysterious papyru that was discovered in the Giza cemetery which explains the ability of sound to abolish gravity and move large stones.

Redfern says that the papyru mentions that the ancient Egyptians used singing and other sounds like music or whistling in their rituals to move objects and stones. This means that they used sound waves, no matter what the source of those sound waves was, to move stones. What really matters in that papyru is that singing, music and whistling all share the same characteristic which is sound—the main working element in acoustic lifting. Moreover, Redfern also mentions in his book other researchers who have discussed acoustic levitation such as Mari D. Jones and Larry Flaxman (Redfern, 2022).

Starting from this point, this research discusses the same hypothesis of Redfern concerning how the pyramids were constructed, and how the ancient Egyptians' architects depended on the theory of gravity abolition to accomplish this construction task. However, Redfern (2022) only discusses the hypothesis without providing scientific evidence or scientific laws to support his ideas. For example, some chapters of the book give explanations about the pyramids' construction that depend on supernatural forces like jinns or aliens that came from other planets.

In short, this research tries to prove with scientific evidence that the construction of the pyramids was based on the abolition of gravity which reflects one aspect of the civilization and scientific advancement of the ancient Egyptians.

1.2. Problem Statement

According to the traditional theory of building the pyramids, the building process

is time consuming and quite ineffective concerning cost and effort. In addition, some manuscripts that were found mentioned the topic of abolishing gravity through vocal lift or the use of skates[1]. What is the role of abolishing gravity in the architecture of the Egyptian pyramids? How can these theories help in raising stones of large sizes?

1.3. Research Objectives

The pyramids are great constructions that must have been built by great experienced architects. However, no study so far has been able to confirm how they were built or what techniques or scientific construction laws did the ancient Egyptian architects follow to reach what can be described as miraculous constructions.

The stones that the pyramids were built from are of huge size and the weight of each stone might reach up to 2.5 tons. The big question is how did the ancient Egyptian construction workers move these stones and/or lift them to their final destination? What techniques did they use to accomplish this mission? Were the techniques used for stone lifting similar or different from the techniques of nowadays?

So many theories have been suggested to explain how the pyramids' stones were moved like the traditional theory and the theory of gravity abolition through acoustic lifting.

This research suggests that gravity abolition was the technique used to move and lift the huge stones but with a different method which is the hydro lifting method through the use of the Nawamis, circular-shaped buildings built from the Nubian sandstone scattered in Southern Sinai.

In this research, the most famous theories that have been proposed to explain how the pyramids' stones were moved are described trying to prove that the theory of hydro lifting is more likely to be the one used at that time due to the presence of a tangible evidence: the Nawamis. This study tries to prove the efficiency of abolishing gravity by the use of the hydro lifting technique in saving time, effort and cost through:

- Introducing the Egyptian pyramids, their importance, the way they were built, and the traditional theory.
- Introducing the concept of abolishing gravity in architecture, and the means of abolishing gravity in lifting large stones: acoustic lifting and hydro lifting.
- The application of the methods of gravity abolition in ancient Egyptian architecture.
- Providing a description of the Nawamis that are considered as a witness from and the ancient Egyptian times and trying to prove that they were the devices used in stone hydro lifting in order to justify the research hypothesis.

2. Overview of the Architecture of the Egyptian Pyramids

The pyramids are huge buildings, mostly dating back to the ancient Egyptian ci-

[1]https://en.wikipedia.org/wiki/Djehutihotep (Last access in 24/10/2021).

vilization. The base of the pyramid is a square, and its walls are four triangles whose vertices converge at one point to form the top of the pyramid. Its walls are in the form of terraces or stairs, and the most famous of which is the pyramid of Saqqara. The pyramids are royal buildings that were built to be tombs for the Pharaohs and their wives. They were built in the period between 2630 BC and 1530 BC (Fakhry, 1963).

2.1. History

However, the story is not over yet as a new notion among researchers has come to doubt the whole idea of considering the pyramids as only tombs for the Pharaohs in which such an idea underestimates the greatness of such magnificent structures. For example, the Great Pyramid does not have mural art, a coffin, or a mummy. This is what has made researchers think of a more logical explanation for the presence of these huge structures: the pyramids were power stations. This explains why it was built above the center of the Earth's surface mass with extreme precision. This is because it is the best place to capture sound waves and release free energy. The Earth's energy produces fields of frequency that the human ear cannot hear; however, these fields of frequency work as harnesses to transport objects.

The Giza pyramids were constructed 'in a span of 85 years between 2589 and 2504 BC' (Ancient Egypt Research Associates, 2022). The pyramids were basically tombs for the kings, queens, and the most remarkable leaders of the Pharaohs. It is estimated the total number of the pyramids is about 138. Each pyramid is a masterpiece that has millions of mysteries waiting to be solved. However, Khufu, the largest of them all, is the only pyramid to be considered as one of the ancient Seven Wonders of the World, and Djoser is probably the oldest one in which its construction probably took place in the period between 2630 and 2611 BC (Ancient Egypt Research Associates, 2022)[2].

However, the story is not over yet as a new notion among researchers has come to doubt the whole idea of considering the pyramids as only tombs for the Pharaohs in which such an idea underestimates the greatness of these magnificent structures. For example, the Great Pyramid does not have mural art, a coffin, or a mummy. This is what has made researchers think of a more logical explanation for the presence of these huge structures: the pyramids were power stations. This explains why it was built above the center of the Earth's surface mass with extreme precision as it is the best place to capture sound waves and release free energy. The Earth's energy produces fields of frequency that the human ear cannot hear; however, these fields of frequency work as harnesses to transport objects (Balizeb, Baryshnikova, Kapitova, & Evlyukhin, 2018). This theory is considered to be the background of the new theories that have emerged about the concept of gravity abolition and using this technique to lift huge stones.

[2]https://en.wikipedia.org/wiki/Egyptian_pyramid_construction_techniques (Last access in 24/10/2021).

2.2. Significance

Pyramids in Egypt are a wonderful destination for tourists. They are evidence of the greatness of the Pharaonic civilizational history of Egypt which many tourists all over the world seek to see every year. This is considered a source of national income for Egypt (Fakhry, 1963).

2.3. Most Famous Egyptian Pyramids:

The most famous pyramids in Egypt are illustrated in Figure 1[3].

- The Pyramid of Djoser (BC 2630) (Saqqara).
- The Bent Pyramid (Southern-Shining-Pyramid) (BC 2600) (Dahshur).
- The Red Pyramid (BC 2600) (Dahshur).
- The Pyramid of Khufu/Cheops (BC 2565) (Giza).
- The Pyramid of Djedefre (BC 2555) (Abu Rawash).
- The Pyramid of Khafre (BC 2545) (Giza).
- The Pyramid of Menkaure (BC 2520) (Giza).

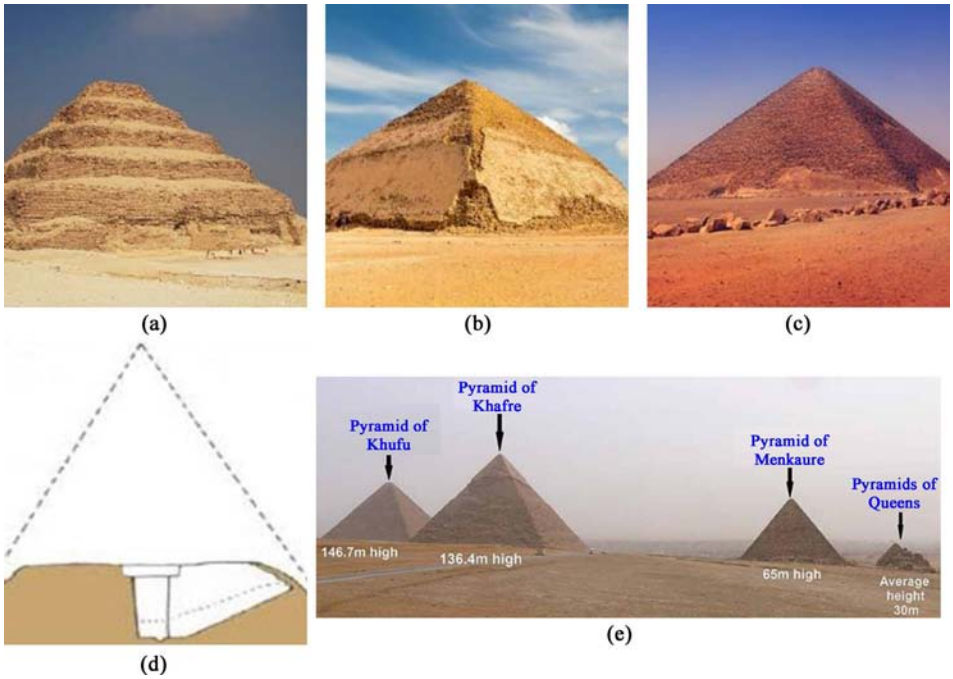

Figure 1. (a) Pyramid of Djoser[4]; (b) Bent Pyramid[5]; (c) Red Pyramid[6]; (d) Pyramid of Djedefre[7]; (e) Pyramids of Khufu, Khafre and Menkaure[8].

[3]http://www.visual-arts-cork.com/ancient-art/egyptian-pyramids-architecture.htm (Last access in 24/10/2021).
[4]https://cdn.mos.cms.futurecdn.net/5DZPt9k3pkVnJCvwPtZPj4.jpg (Last access in 15/1/2022).
[5]https://www.tripsinegypt.com/wp-content/uploads/2018/12/History-of-the-Bent-Pyramid-Trips-in-Egypt-1.jpg (Last access in 5/2/2022).
[6]https://www.yallatours.com/blog/wp-content/uploads/2020/09/dahshur.jpg (Last access in 20/1/2022).
[7]https://encrypted-tbn0.gstatic.com/images?q=tbn:ANd9GcR1gXlyLXNMbUAtNOUh-BWoJoFgfHVsz21P0w&usqp=CAU (Last access in 15/1/2022).
[8]https://3.bp.blogspot.com/-1LrB6MHz5z8/XqIbZ_Q3wCI/AAAAAAAAHJU/HtZorzWJX_UIK29pjYHUZdMllIOe8IvCQCK4BGAYYCw/w1200-h630-p-k-no-nu/Pyramid-Khafre3.jpg (Last access in 5/1/2022).

2.4. Phases of Building the Pyramids

The pyramids were built in three phases:

- Phase 1: Selecting the best site for the building
- Phase 2: Preparing the site
- Phase 3: Raising the blocks

Phase 3 (raising the blocks) is a controversial issue and is the main interest of this research[9].

3. The Traditional Theory and the Architecture of the Egyptian Pyramids

Moving huge amounts of stones was one of the main problems that early pyramid builders faced. The Twelfth Dynasty Jehuhotep tomb contains an illustration of 172 men pulling a statue of him onto a sled. Experiments conducted by Obayashi with concrete blocks measuring 0.8 m^2 base and 1.6 m height and weighing 2.5 metric tons (2500 kg; 5500 lb) showed how 18 men could pull the block up an inclined slope at a rate of 18 m/min (Cassel, 2017).

It is still unknown if the Egyptians used this method, but experiments indicate that it could have worked with stones of this size. Egyptologists generally accept this method for the 2.5-ton blocks used mostly but do not agree on the methods used for blocks over 15 tons and blocks from 70 to 80 tons.

3.1. Approved Principle

The blocks were moved on ramps by sled, likely lubricated with water. The leveling of the foundation may have been accomplished using water-filled trenches as suggested by Mark Lehner and Edwards or through the use of a rough square level and the use of experienced surveyors.

Most Egyptologists admit that ramps are one of the most common methods of lifting blocks, yet they do admit that it is an incomplete method that must be completed with another device. Archaeological evidence of the use of cliffs has been found at the Great Pyramid of Giza and other pyramids. The most acceptable way to help slopes is lifting. Archaeological records only provide evidence of small ramps and sloping bridges—not something that could have been used to build even the majority of the pyramid (**Figure 2**).

The famous decoration inside Jehutihotep's tomb which represents the transport of a colossal statue of him which was 6.8 m high and was moved by 172 workers using ropes and slides in an effort facilitated by pouring water in front of the slide. The statue has an estimated weight of 58 tons. The image of the giant itself was vandalized and irreparably destroyed in 1890 and all current drawings are based on a single photograph taken the previous year by Major Brown[10]. It is assumed that 5% of water facilitates transport by about 30%.

[9]https://www.memphistours.com/Egypt/Egypt-Wikis/Egypt-Pyramids/wiki/pyramids (Last access in 24/10/2021).

[10]https://en.wikipedia.org/wiki/Djehutihotep (Last access in 24/10/2021).

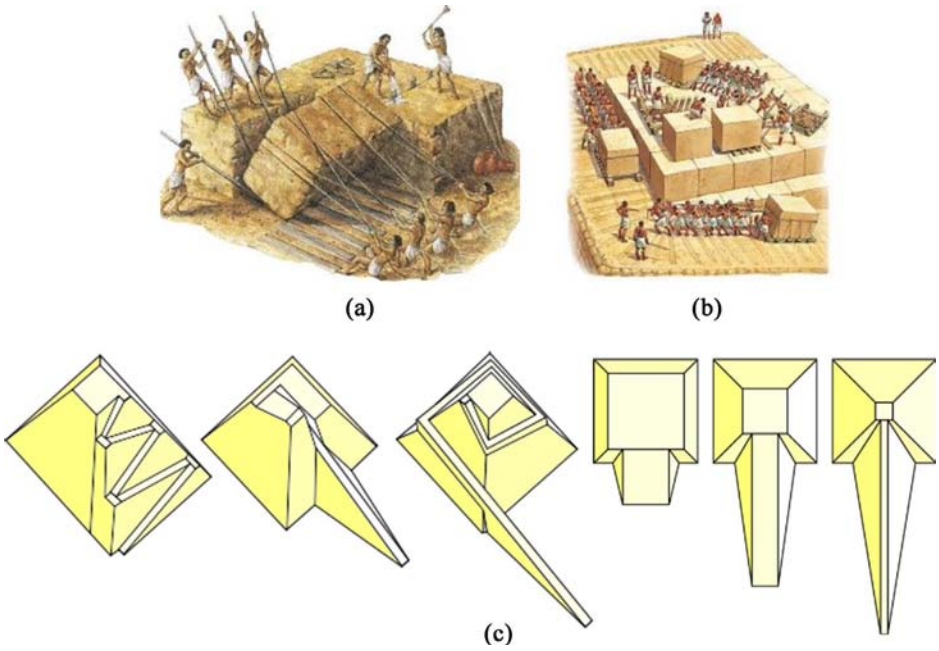

Figure 2. (a) Cutting the stone[11], (b) Moving the stone[12], (c) Different ways of the ramps[13].

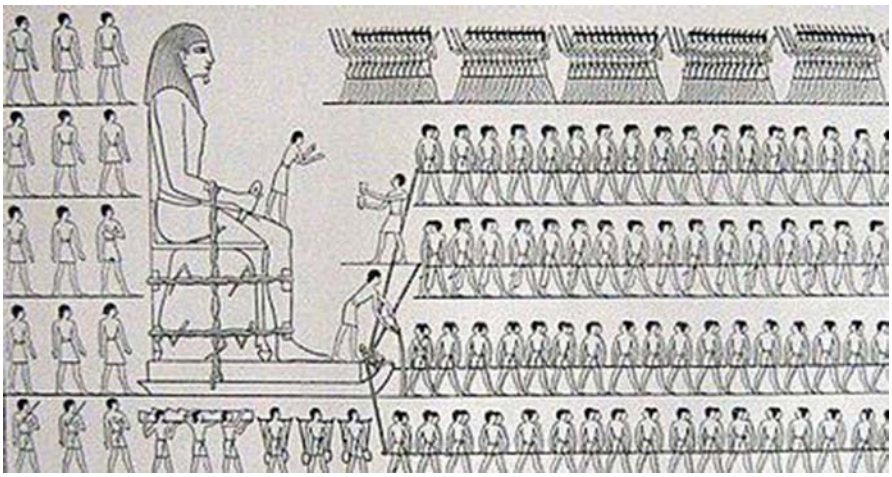

Figure 3. Carriage scene in the Colossus showing water pouring into the path of a sleigh[14].

Egyptologists long dismissed this way and considered it as ritualistic. But now, it is confirmed to be possible in which it helped to harden the sand and poten-

[11]https://res.cloudinary.com/dk-find-out/image/upload/q_80,w_1920,f_auto/l_cutting_8b_kw500_c_zanrgv.jpg (Last access in 10/1/2022).
[12]https://i.pinimg.com/564x/b1/dd/88/b1dd887eed3e4abf818beb208e90249c--wooden-posts-cartoon-design.jpg (Last access in 15/1/2022).
[13]https://upload.wikimedia.org/wikipedia/commons/thumb/9/95/Other_ramps1b.svg/423px-Other_ramps1b.svg.png?20111225174336
https://upload.wikimedia.org/wikipedia/commons/thumb/3/3b/Straight_on_ramps1a.svg/800px-Straight_on_ramps1a.svg.png (Last access in 24/10/2021).
[14]https://upload.wikimedia.org/wikipedia/commons/thumb/7/7f/Colosse-dj%C3%A9houtih%C3%A9tep2.jpg/1280px-Colosse-dj%C3%A9houtih%C3%A9tep2.jpg (Last access in 10/11/2021).

tially reduce the force needed to move the statue by 50%, as in **Figure 3**.

3.1.1. Internal Ramp Model

The idea that the pyramids had been built from the inside was started in 1999 by Henri Houdin, the engineer and the father of the French architect Jean-Pierre Houdin who presented a controversial theory about the way the Great Pyramid of Giza was constructed. To prove the validity of his theory, Jean-Pierre Houdin used an advanced 3D modeling technology that helped him to identify a construction anomaly that Jean-Pierre and his group of researchers named "the spiral structure". It looked exactly like a ramp built inside the pyramid, **Figure 4** (Tran, 2008).

Houdin's work has focused particularly on the Great Pyramid of Giza (the Pyramid of Khufu), which is said to have been built for Pharaoh Khufu over a period of 20 years, circa 2500 B.C. It is the only pyramid that is still largely intact and weighs around six million tons, out of the 2.3 million blocks of limestone and granite used with some weighing up to 80 tons. For years, many researchers have argued over how this colossal monument could have been built with the tools and equipment available during the 4th Dynasty (Tran, 2008).

In 2005, a group of researchers included Houdin, the Egyptologist Bob Brier, Tayoubi, Breitner, and a team of engineers from Dassault Systèmes. Their main scheme involved the use of a regular external ramp to build the first 30% of the pyramid, with an "internal ramp" taking stones up beyond that height. The stones of the external ramp were re-cycled into the upper stories, thus explaining the otherwise puzzling lack of evidence for ramps.

In Houdin's method, each ramp inside the pyramid ended at an open space, a notch temporarily left open at the edge of the construction. This 10-square-meter clear space housed a crane that lifted and rotated each 2.5-ton block to ready it for eight men to drag up the next internal ramp. These notches were scattered in the right positions in the pyramid to facilitate the rotation of the cranes and the

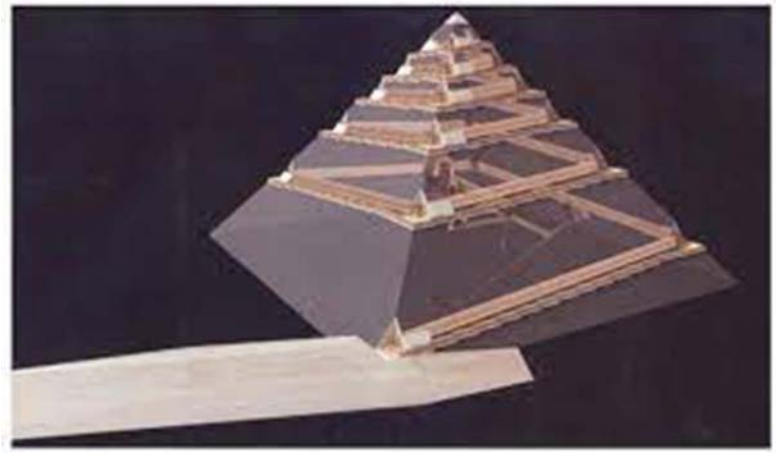

Figure 4. 3D diagram of the internal ramp[15].

[15]https://i2.wp.com/matterundermind.com/wp-content/uploads/2018/03/screen-shot-2013-12-10-at-10-42-56-am.png?fit=900%2C535&ssl=1 (Last access in 22/2/2022).

stones as a result.

In building this internal ramp, Hemienu (the ancient Egyptian, Vizier, and architect who is believed to be the one who built the Great Pyramid of Giza) had an important task which was protecting the chambers and the internal passages of the pyramid from being damaged or hit while moving the huge stones. Another task for Hemienu was making sure that the workers had the capacity to turn the stones around the pyramid's corners at an angle of 90 degrees. Houdin believes that the process of stone moving was achieved by wooden cranes that were placed in the openings of the ramp. The ancient Egyptians were familiar with the concept of cranes in which they used shadoofs to lift water from the Nile. It is more likely that shadoofs were adjusted to become cranes in order to be used for the building of the pyramid.

The pyramid is not solid. Inside, there are three large rooms. The lowest is called the queen's room, above it is a mysterious room called the great gallery, and at the top is the king's burial chamber. These three rooms are connected by passages. The ramp never touched any of the rooms or passages inside the Great Pyramid. For the first time in history, a 3D structural model was built to test the ramp theory, **Figure 5** and **Figure 6** (Tran, 2008).

Figure 5. Internal ramp- prospective and site plan[16].

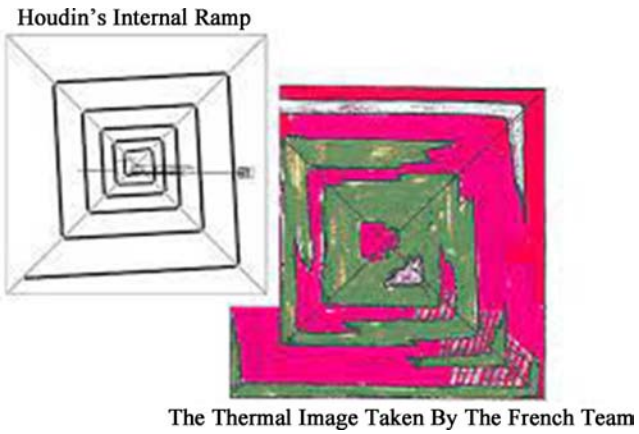

Figure 6. Picture of the space inside the pyramid[17].

[16]https://cdn.images.express.co.uk/img/dynamic/78/590x/secondary/The-proposed-theory-on-how-the-Great-Pyramid-was-built-2569927.jpg?r=1594798582743 (Last access in 15/1/2022).

[17]https://external-preview.redd.it/NqKcWXlETY8xoWZ-a0-7I2cc77e70trMRzf-B6JNOY0.jpg?auto=webp&s=e9730bc79c7740019eabfb00cc5b3b68db82ab6b (Last access in 15/1/2022).

3.2. Evaluating the Traditional Theory

As previously mentioned, the method of transporting heavy blocks across the slopes to build the pyramids is a method that requires time and effort, and there is no physical evidence of the existence of remnants of the use of the slopes. In addition, the method may be effective when using auxiliary means such as lifting. The shapes of the slopes are different and complex and need to be built themselves. Is this method simple in concept and complex in implementation? Was it the only method used in an advanced civilization like the ancient Egyptian civilization? Another question is raised in this situation when it comes to the construction of obelisks that are known for their considerable heights and gigantic sizes. Were ramps the method for the construction of obelisks? It is doubted that ramps (according to the traditional theory) were the only method of construction at the time of the ancient Egyptians especially when it comes to huge constructions like the pyramids and obelisks.

4. Abolition of Gravity in Architecture

4.1. Definition

The Earth's gravity is a force that causes objects to move toward its center. This force cannot be absorbed, transformed, or armed against. Gravity enables humans to move comfortably on horizontal surfaces, and allows structures to be stable on the surface of the earth. The Earth's gravity is constant in its value, controls all the masses on its surface, and determines the weight of each mass.

Anti-Gravity, which is known as a non-gravitational field, is a hypothetical phenomenon of creating a place or object that is free from the force of gravity. It is stated that gravity 'does not refer to the lack of weight under gravity experienced in free fall or orbit, or to balancing the force of gravity with some other force, such as electromagnetism or aerodynamic' (Wei, Li, & Gao, 2018).

4.2. Objective

The goal of abolishing gravity in architecture is to study the concept of building construction and resisting the various forces of nature such as earthquakes, hurricanes, gravity, etc. The abolition of gravity also plays a role in facilitating the lifting weights and heavy loads by using the forces of sound and electromagnetic waves and fluid flow, which reduce both effort and time (Abdul Jalil, 2018).

4.3. Ways to Abolish Gravity in Lifting Large Bodies

There are many ways to get rid of the burden of lifting loads by abolishing the forces of gravity. The most important of which are:

- Acoustic Lift.
- Hydro Lift.

4.3.1. Acoustic Lift

It is sonic lifting (Acoustic Levitation) or swimming on a wave of sound (Fontana

& Liu, 2016). The idea that something intangible can lift things up may seem incredible, but it is a real phenomenon. Acoustic levitation takes advantage of the properties of sound in order to make solids, liquids, and heavy gases float above a sound wave. The process of acoustic levitation can be done in normal or low gravity. In other words, sound can lift objects on Earth or in space (Röthlisberger, Schuck, Kulmer, & Kolar, 2021).

Acoustic levitation experiments are common and ongoing. Some researchers have already been able to use sound waves to lift and move small particles and liquid droplets. Multiple vibrating plates are used to create different frequencies and move the sound field as in **Figure 7**[18] (Röthlisberger, Schuck, Kulmer, & Kolar, 2021).

4.3.2. Hydro Lift

Hydraulic jacks are tools used to lift heavy objects such as the levers in auto repair shops, in wheelchairs, and even on skyscraper construction sites. They use water (or other liquids) to increase the force available to lift objects. The experiment in (**Figure 8**) explains how to design one of these levers in which it demonstrates

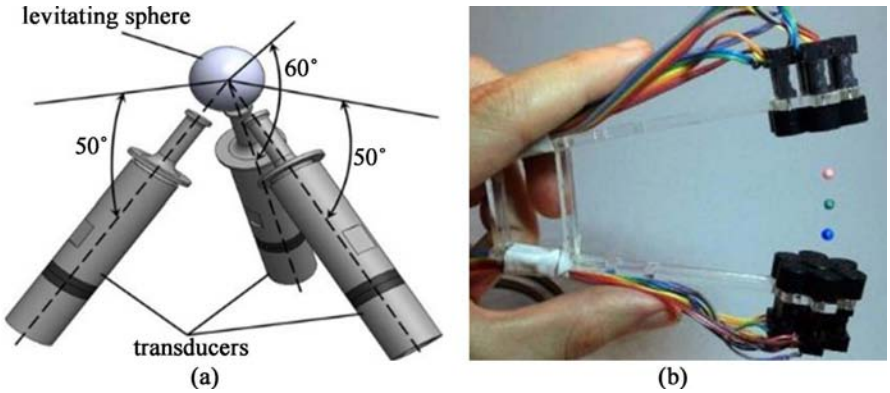

Figure 7. (a) Acoustic levitation[19]. (b) Sonic lifting[20].

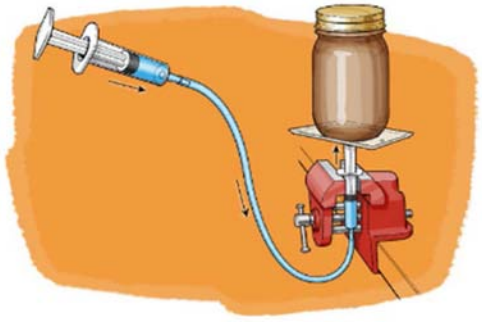

Figure 8. Fluid energy: A design for a lever that uses water as an aid[21].

[18] https://www.sasapost.com/acoustic-levitation/ (Last access in 24/10/2021).
[19] https://qsstudy.com/wp-content/uploads/2020/11/vResearchers-demonstrate-acoustic-levitation-of-a-large-sphere.jpg (Last access in 15/1/2022).
[20] https://wonderfulengineering.com/wp-content/uploads/2017/01/gauntlev-1.jpg (Last access in 20/2/2022).
[21] https://static.scientificamerican.com/arabic/cache/file/014FFCB0-924F-4044-8B418577B3240274.jpg (Last access in 5/3/2022).

how easy it is to lift objects with the use of hydropower (Wei, Li, & Gao, 2018).

When moving an object, exerting a force is not enough because the force must be distributed over the entire area of where it is exerted, as in **Figure 9** (Mahmoud, Salih, & Moneer, 2017).

5. Application of Methods of Abolishing Gravity in Ancient Egyptian Architecture

A number of researchers and studies referred to the theory of abolishing gravity when lifting huge stone blocks weighing 2.5 tons and more (Cassel, 2017). On the one hand, the theory of Acoustic Lift is the one in circulation up to this date. On the other hand, this research sheds light on the theory of Hydrolift with reference to evidence of its use.

5.1. Common Theory of Absorption of Gravity in Ancient Egyptian Architecture (Sound Lifting)

5.1.1. Principle

The technique of Sound Lifting has not been used to lift heavy or large objects, and scientists have not yet known whether such a technique is possible, but their findings so far suggest that large-scale sonic hovering may one day be possible (Sundvik, Salmi, Nieminen, & Panula, 2015).

However, there are no direct accounts to confirm the use of the technique of Sound Lifting, with the exception of testimony written by Abu Al-Hasan Ali Al-Masoudy, a tenth-century Arab historian, about ancient Egypt and the methods he allegedly used to move huge stones, including those used to build the pyramids[22]. He claimed that a magical papyrus imprinted with symbols was placed under each stone, after which the stone was struck with a metal rod that leads to the height of the stone and moves it along a path paved with stones and fenced on both sides with metal poles. Some scientists believe that these electrodes could have been used to create high-frequency sound vibrations, and these vibrations can be considered to be responsible for lifting the huge stones.

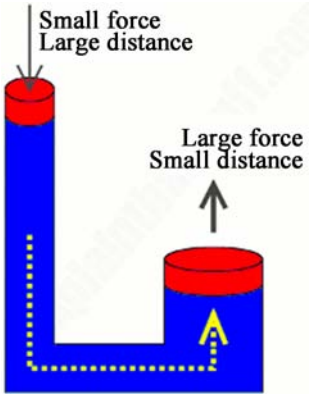

Figure 9. Hydrolift method[23].

[22] http://egy-pyramids.blogspot.com/2011/05/blog-post_16.html (Last access in 24/10/2021).
[23] https://cdn4.explainthatstuff.com/hydraulic2.png (Last access in 20/3/2022).

In addition, a team of architects and Egyptologists confirmed that the Pharaohs were able to abolish the Earth's gravity when lifting the stones that were used in building the pyramids and moving them over long distances by directing special sound vibrations and electrostatic charges to facilitate the process of lifting them (Fontana & Liu, 2016).

5.1.2. Physical Evidence Supporting the Theory

Sayed Karim, a professor of architecture at Cairo University and an expert in Egyptology, told Al-Ahram Journal that two papyri were discovered and that they gave valuable information about the method used to construct the pyramids. The two papyri are now in two different places: One is in Karnak and the other is in Paris. The former papyrus is in an architect's tomb who belonged to the Middle Kingdom, and the latter is in the Louvre Museum, **Figure 10**.

In 1993, an inaccessible room known as the "lower chamber" was found under the Great Pyramid. In 2011, thanks to technological development and the use of cosmic ray-based imaging, what was inside this room (void) was discovered: it was just a void. Scientists could specify the dimensions of the void, but they were not certain about the purpose of that void which 'it could have been a burial chamber, another gallery, an architectural anomaly, or simply a sealed-off construction passage' (Rubin, 2017). However, some historians and experts still have the hope to prove that such a void had an important role in transforming the earth's gravity into high-frequency sound vibrations that played the role of Acoustic Lifting (**Figure 11**).

The Egyptians used dolomite on the inner sides of the stone's walls. This mineral is known for its doubling electrical conductivity. In addition, tunnels and underground passages (paths) were lined with radioactive granite and quartz crystals which are great conductors of piezoelectricity by directing the sound waves emanating from the center of the Earth through the pyramid and intensifying them to the highest frequencies by passing them through passages

Figure 10. Papyrus that the British "Daily Mail" report[24].

[24]https://aawsat.com/sites/default/files/styles/article_img_top/public/2017/09/24/daily-250917-8.jpg?itok=oGNZe7yK (Last access in 20/2/2022).

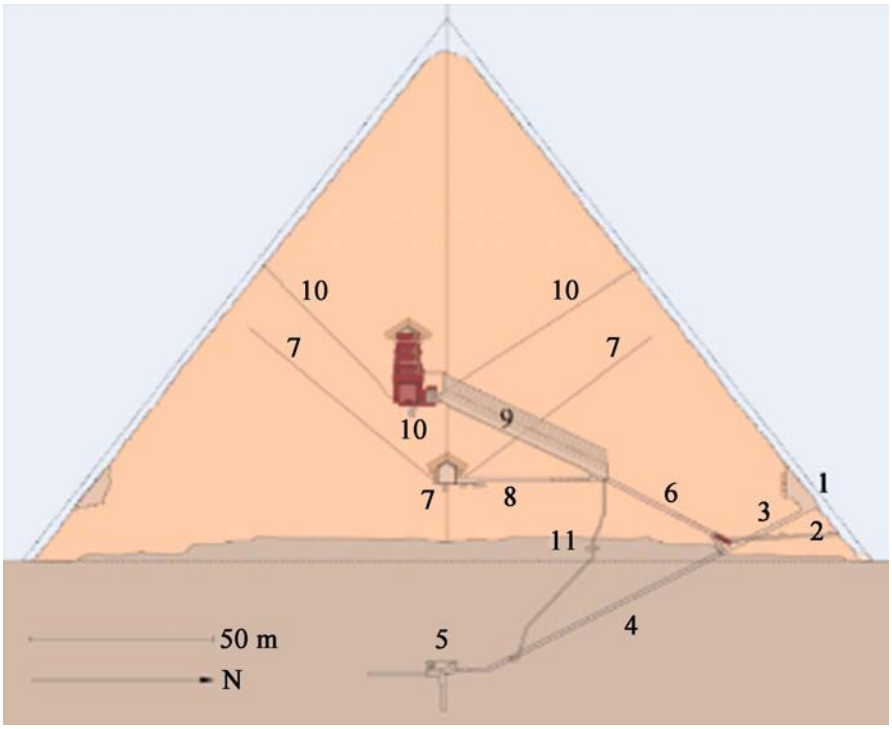

Figure 11. Great Pyramid Diagram[25].

supplied with water that works as a jet engine. In this situation, the quartz crystals vibrate in water which has an effect on the sound waves speed which is quadrupled if compared to the speed of the sound waves affected by the vibrating quartz crystals in the air. This can be called anti-gravity (Schwabl, 2006).

With the presence of the metal coils at the base of the pyramid, these waves are generated, and they are filtered in side chambers through the granite layers to turn into frequency-calculated resonance energy. The quartz crystals on the surfaces of the granite blocks work to condense sound waves to generate electromagnetic fields and electrostatic charges. The result is a repulsion between the stones and the earth, so the stones rise from the ground to be controlled by a polarizing column of energy consisting mainly of three parts: a ceramic bowl, a copper tube with an iron rod inside it, and an acid liquid that produces the outgoing reaction that is formed by striking the stone with the polarized column. This leads to the rise of the stone and moving it through a path paved with stones. The stone reaches a certain distance, and the process is repeated until the stone reaches to the desired and specified place (**Figure 12**) (Massey, 2014).

To sum up, the theory of Sound Lifting is that when the pyramids were being built, their stones were raised with reverse engineering techniques and free energy that was generated through the base of the pyramid and the inner corridors that absorb any rays and release or pull these rays from the underground to transform them into electromagnetic vortices.

[25]https://upload.wikimedia.org/wikipedia/commons/thumb/3/39/Great_Pyramid_S-N_Diagram.svg/738px-Great_Pyramid_S-N_Diagram.svg.png.

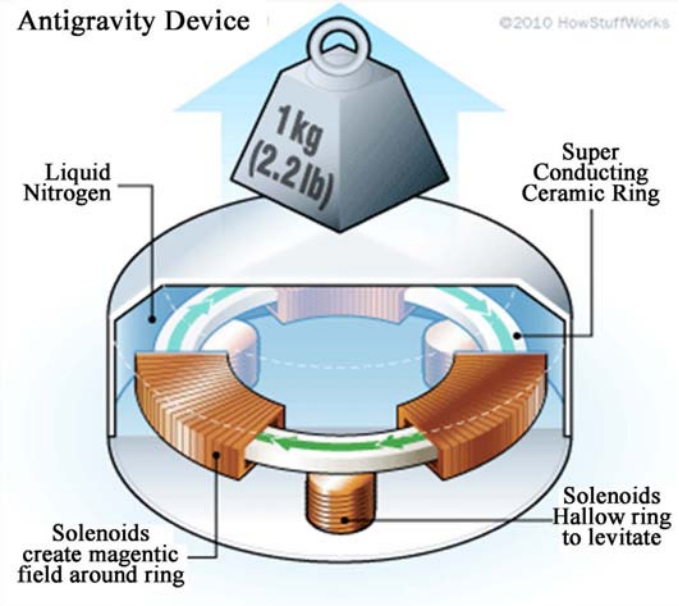

Figure 12. Antigravity technology[26].

5.2. Theory Proposed (Hydro Lifting)

5.2.1. Principle

This research indicates the possibility of adopting the theory of water lifting to justify how the process of lifting large weights was performed. According to Ref.[27], the method of water lifting is a means of facilitating the transportation of huge stones using waterslides.

5.2.2. Physical Evidence to Support the Theory (Nawamis)

The Nawamis civilization is older than the Pharaonic one which they were constructed 1500 years before the construction of the pyramids. They exist in Southern Sinai, and they were used as residences and tombs.

1) Definition

Al-Nawamis (singular namus) are circular-shaped buildings built from the Nubian sandstone scattered in Southern Sinai. Each namus has a small door and an opening in the roof. There are more than a thousand Nawamis in the valleys of South Sinai, as well as a group of similar buildings that are all registered in Halaib, Southeast Egypt. Moreover, they can also be found in many different locations in Egypt.

Al-Nawamis (or the Nawamis) are stone buildings in which each building is built in the form of circular rooms made of large stones, each of which varies in diameter from 1 to 3 m. The nets were built without adhesive to the stones.

Khaled Elyan, Director General of Saint Catherine's Antiquities said: "Experts differed and opinions varied about why prehistoric people built these buildings. Some say that they are dwellings, and the first appearance of the idea of gathering and tribe, while others believe that they were tombs, and a third opinion ap-

[26]https://cdn.hswstatic.com/gif/antigravity.gif.

[27]https://en.wikipedia.org/wiki/Djehutihotep (Last access in 24/10/2021).

peared, that they were used for hunting animals" As shown in **Figure 13(a)** & **Figure 13(b)** (Ibrahim, 2017).

2) Methods of building

As mentioned before, the Nawamis existed before the pyramids, so the concept of circular buildings with small diameters was not new. Therefore, this research assumes that these types of buildings were used to make a water lift (hydraulic) as presented in the illustration in (**Figure 9(a)**) in which these Nawamis of different diameters were filled with water and a certain pressure was applied to enable these devices (Nawamis) to lift heavy weights (Goren, 2002).

6. Comparison between Ancient and Contemporary Theories

- The traditional method is costly and time consuming and can be adopted if there is another auxiliary method as mentioned previously.

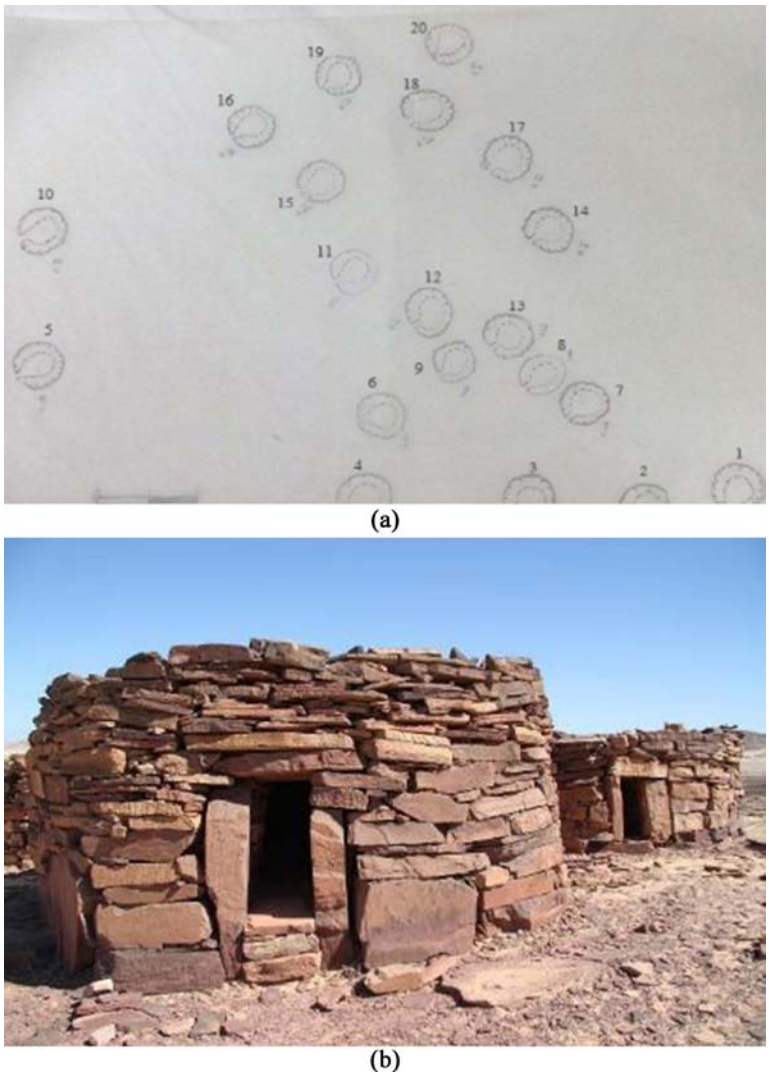

Figure 13. (a) Nawamis places (Ibrahim, 2017). (b) Nawamis shape[28].

[28]https://media-cdn.tripadvisor.com/media/photo-m/1280/1a/92/d8/25/the-sinai-desert-nawamis.jpg (Last access in 15/1/2022).

- What kind of vocalization took place in Acoustic levitation? Did hitting the rock cause the vibrations that led to the sonic levitation? On the other hand, did the design of the stones and rods cause magnetic levitation? Magnetic levitation occurs when an object is suspended in the air using only magnetic fields without any other support.
- Hydrolifting method is one of the most feasible methods compared to acoustic lifting, and it can be adopted in combination with the previous traditional method.

A comparison can be made between the three methods as shown in Table 1.

7. Application of the Theory of Water Lifting in the Construction of the Pyramids

The proposed theory depends on the principle of water lifting vertically huge stones and then moving them horizontally, depending on water and the application of Pascal law in hydraulic press. The process requires two Nawamis (that are considered as cylinders) in which one of the two Nawamis is considerably larger in size than the other. The two Nawamis are connected to each other, and the smaller Namus is filled with an incompressible liquid (water in this case)[29].

Assume that, $A1$ is the small stone, $A2$ is the big stone, $R1$ is the small piston radius (m), $R2$ is the large piston radius (m), $d1$ is the distance a small weight lifts (m), $d2$ is the distance a large weight lifts (m), $F1$ is the small stone weight (kg), and $F2$ is the big stone weight (kg). The hydrolift suggestion steps are shown in Figure 14(a) & Figure 14(b) as in the following:

- Putting the large stone in place and closing the Nawamis well.
- Filling the void with water.
- Putting the small stone in its place.
- The large stone rises due to the pressure difference upwards until reaching the appropriate level.
- Moving the stone horizontally using water pouring to make it easy to pull.

The process was repeated by emptying the Namus which was linked at the same time with another Namus (as shown in Figure 13(a)). Furthermore, at the time of floods, the water of the floods was used bor both filling the Nawamis with water and increase the speed of the whole process of hyrdrolic press (Hydrolifting).

Table 1. Comparing between the three methods (Source: The researcher).

Method	Traditional	Acoustic levitation	Hydrolifting
Save time	X	X	
Save cost	X		
Save effort	X		
Adoptable		X	

[29]https://www.youphysics.education/hydrostatic-pressure/pascals-law (Last access in 20/11/2021).

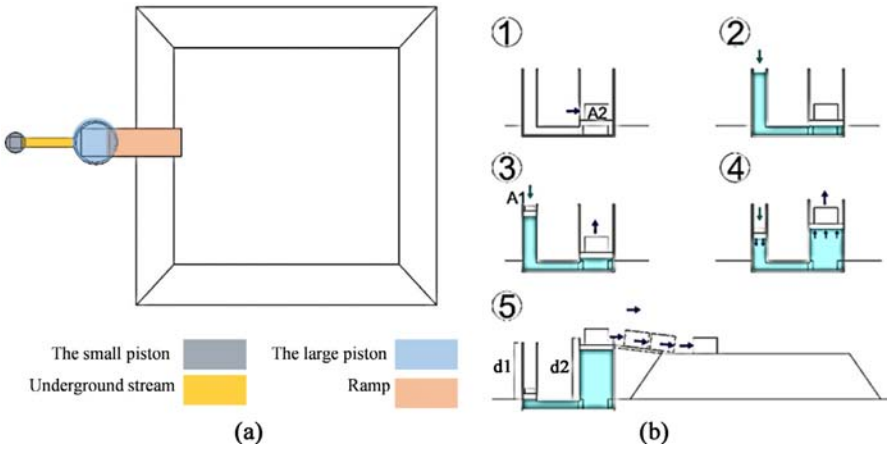

Figure 14. (a) Site plan of the suggested method, (b) Steps of the suggested method (Source: The researcher).

Figure 15. The unfinished obelisk near Aswan, Egypt[30].

Pascal's law calculations:

$$F1 \div F2 = R1 \div R2,\ F2 = \ 2500 \text{ kg},\ R1 = 3 \text{ m},\ R2 = 1.5 \text{ m}$$

$$\rightarrow F1 = F2 \times (R1 \div R2) = 2500(1.5 \div 3)$$

$$\rightarrow F1 = 1250 \text{ kg}$$

$$F2 \div F1 = d1 \div d2,\ d1 = 50 \text{ m}$$

$$\rightarrow d2 = d1 \div (F1 \div F2) = 50(1250 \div 2500)$$

$$\rightarrow d2 = 100 \text{ m}$$

8. The application of the Theory of Water Lifting in the Construction of Obelisks

Obelisks were carved at the site and raised 90 degrees, Figure 15. Water lifting can be used to lift large sizes vertically. However, when it comes to obelisks, large blocks can be slipped through water in order to be moved at an angle of 90

[30]https://www.egypttoursportal.com/images/2018/09/The-Unfinshed-Obelisk-Egypt-Egypt-Portal.jpg (Last access in 15/1/2022).

degrees.

When lifting a stone under water, the buoyant force applied by water helps. But, in the case of air, the force is small, which needs to apply more force for lifting the same stone.

When the obelisk was going through the process of construction, it was in a horizontal position. After the construction work was finished, another difficult task was facing the workers at that time: transporting the obelisk to the wanted location (**Figure 14**, illustration 1) and then changing its position from horizontal to vertical one (**Figure 14**, illustration 4) by going through the following steps (**Figure 16**)[31]:

1) Due to its extremely heavy weight, it is carried vertically on level ground (illustration 1).

2) The obelisk is pulled down to fit in its assigned position as in (illustration 2).

3) As the bottom of the obelisk comes down, its top goes up as in (illustration 3).

4) The obelisk fits right in a vertical position as in (illustration 4).

The space surrounding the obelisk in Aswan, formerly known as Swenett at the time of Ancient Egypt, was filled with water to facilitate the lifting process.

This research has been conducted due to the following important points:

1) The number of stones used for building each pyramid is really huge and might reach up to one million stones. Each stone might weigh about 2.5 tons. With these huge numbers and masses of stones, the traditional theory of building the pyramids and stone moving/lifting seems to be weak and time consuming and requires much more than 85 years, the estimated time for building a pyramid.

2) The pyramids were constructed during flood times which give an explanation of how the ancient Egyptians managed to use huge amounts of water for

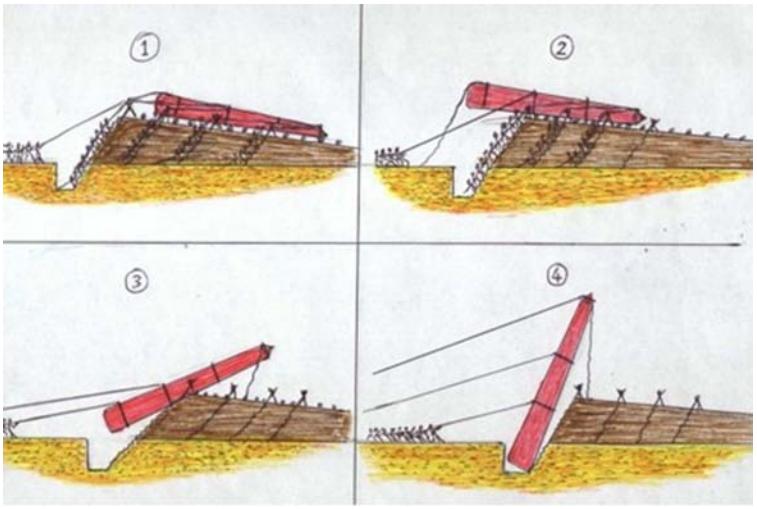

Figure 16. Way to lift the obelisk[32].

[31]https://www.quora.com/Why-it-is-easier-to-lift-a-stone-under-water-than-in-air-1 (Last access in 20/11/2021).

[32]https://qph.fs.quoracdn.net/main-qimg-692563268b18577c780922fe7f50f0ad (Last access in 15/1/2022).

stone lifting.

3) The Nawamis, which are up to this date considered as constructions with unknown specific functions, were built with a high level of proficiency and accuracy. It does not seem logical that the ancient Egyptians built them for no good reason or important function.

4) The ancient Egyptian architects used a lot of scientific techniques; however, only have very few of these techniques been discovered so far. It is with research only that scientists are able to unveil the secrets of great ancient civilizations like the ancient Egyptian civilization. Using weak explanations for building the pyramids (most are based on science fiction like the aliens' building of the pyramids or even some supernatural forces or miracles behind the building of the pyramids) underestimate the ability of science and scientific research to discover how the pyramids were built.

5) The techniques and theories that the ancient Egyptians used for building the pyramids have been scientifically proved by many scientists like Blaise Pascal and their theories as mentioned in the book Generalized Pascal Triangles and Pyramids (Russell & Cohn, 2012). Therefore, this is can use as evidence of the advanced techniques and scientific methods that the ancient Egyptians used to build the pyramids.

6) No papyri or hieroglyphic writings whether in the form of drawings or carvings on the walls of the pyramids or any ancient Egyptian constructions refer to any of the scientific theories or methods that the ancient Egyptians used to build their pyramids. It is possible that these theories and methods were verbally mentioned only during their rituals.

9. Conclusions

- This research proposes an innovative and feasible scientific method for building the pyramids depending on water lifting for moving huge stones, aiming to change the traditional stereotyped concepts.
- The abolition of gravity in the architecture of the Egyptian pyramids can be considered simple if compared to the development of the Pharaonic architecture.
- The acoustic lifting technique cannot be adopted as it cannot be used for large sizes, and there is no evidence of the use of sound or electromagnetic waves in the Pharaonic architecture.
- Water lifting is one of the most prominent solutions that helps in lifting blocks of large sizes.
- Hydrolift saves effort, money and time and can be simply adopted.
- The Nawamis are tangible evidence of the possibility of adopting the technique of water lifting to lift huge masses.
- The absence of material remains related to the use of buildings similar to the Nawamis does not mean that the Nawamis were not used because there is also no material remains to prove the existence of slopes in the traditional

theory.

- Regardless of the use of the Nawamis, the principle of a circular building with different diameters can be adopted and used for water lifting.

10. Recommendations

The research recommends conducting further studies related to the techniques of abolishing gravity when lifting large sizes. These studies should refer to the historical importance of the technique of gravity abolishing and search for evidence of its use to prove its validity.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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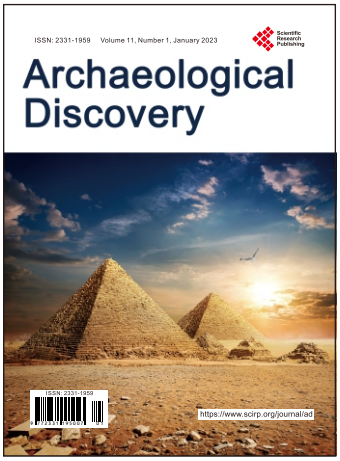

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