Evidence from the Ancient World on Long-Term Preservation of Artifacts - 15442

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ABSTRACT

As a cradle and crossroads of civilizations, a bridge between the ancient political and cultural centers of Mesopotamia and Egypt, and home to three major religions, the land of Israel is rich with archeological artifacts. Dating back thousands of years, many such artifacts have been preserved in remarkable condition – enduring the tumultuous test of time, environment, and regional turmoil. The study of these artifacts can undoubtedly serve as an analogue for a modern, permanent marker system for a geologic nuclear waste repository, shedding light on how a marker can endure man-made and natural disasters over thousands of years. Indeed, these artifacts, and our ability to decipher their various messages, not only provide us with a rich knowledge of our ancestors from the past, but they likewise provide insight into the techniques and conditions needed for long-term preservation and endurance of man-made items over time.

INTRODUCTION

From ancient to modern times, the land of Israel has served as a crossroads for civilizations and a focal point for historic events. Home to the world's three monotheistic religions, the land is rich with culture and history. Antiquities remaining from these periods have remarkably survived both political turmoil and environmental damage over thousands of years, allowing researchers to shed light on the ancient past. However, aside from their historical and cultural significance, such remaining artifacts can furthermore provide insight into what conditions are conducive to long-term preservation and endurance of man-made items over time.

From the first official archeological excavations conducted in 1851 by the French Researcher Pierre de Saulcy at the church in Masada, to the almost countless archeological sites spread across the region today – the land of Israel is a rich source of such evidence and insight. [1] Valuable lessons can be drawn from various archeological sites around Israel by understanding what conditions – be they man-made or environmental – allowed for such ancient artifacts to survive. Some of these artifacts date back as old as 800,000 years, many of which are in relatively remarkable condition for their age.

In the future, permanent markers for nuclear waste repositories will be used to identify the sites, indicate their nature, and warn future generations of the potential hazards. These markers must be durable, lasting for up to 10,000 to 1,000,000 years, and must be capable of maintaining messages understood by future generations. Accordingly, by drawing from examples of artifacts that survived hundreds of thousands of years, facing both natural processes as well as conflict and wars, we will discuss the factors influencing long-term preservation of artifacts. These

factors can be used as indicators of how a modern marker should be composed in order to survive for a similar time frame.

FACTORS INFLUENCING THE LONG-TERM PRESERVATION OF ARTIFACTS

The state and condition of an artifact when it is discovered is dependent on a number of factors. The nature and structure of the artifacts themselves, the environment in which they are buried or stored, and the man-made and environmental interaction they have with their surroundings, will all play a role in how well-preserved a artifact is prior to receiving conservation and restoration treatment. Relatively few artifacts are able to survive at all over long periods of time, and generally only very durable materials – such as stone, bone, ceramics or metals – manage to withstand the natural and manmade threats they face.

Archeological artifacts recovered from earth and water are generally altered from their original state as a result of various physical, chemical and biological influences. Artifacts buried in the ground, such as pottery, will erode physically or become broken down or stained, and composition of the surrounding soil may be an important factor in how well preserved the artifact is. Glass and metals may face both physical deterioration and chemical breakdown. Organic materials such as wood, leather, and textiles are subject to biological decay based on activity of living organisms in the burial site. [2]

Organic artifacts made of wood, leather, and other fragile and organic material are more susceptible to deterioration and rarely last for thousands of years. Organic artifacts include those made from animal products, such as fur, leather, wool, silk, bone, ivory, as well as those made from plant products, such as wood, paper, cotton and other natural fibers. In general, inorganic materials are more stable and less vulnerable to environmental damage. [3]

However, aside from the composition of the material itself, environmental conditions also play a crucial role. Exposure to water and oxygen will cause an organic artifact to decay more rapidly. Very dry climates in desert regions may help to preserve normally perishable objects, since heat and lack of moisture can help prevent natural decay. High altitude areas where there is less oxygen, and cold areas lacking in liquid water, may also provide the right conditions for the preservation of organic material. [4] Composition of the soil is an important factor as well, since the chemicals of plant or animals may reach with minerals in the soil and prevent or expedite decay. Likewise, while organic material will decay quickly in temperate region, they may stand a chance of being preserved in an underwater setting.

In a salt water environment, artifacts can often be quite well preserved but fragile, prone to more easily break apart. Artifacts from anerobic marine environments, buried under sediment on the sea floor for example, are often in much better condition than those from aerobic marine environments (the water column and surface sediment). In general, underwater archeological sites, whether in fresh or salt water, include submerged refuse sites, shrines or sacred sites, shipwrecks, or inundated settlements or harbors. [5]

Of course, natural disasters – such as floods, earthquakes and volcanoes – will also play a role, along with modernization and political turmoil such as warfare and conflict, which can be destructive of valuable artifacts and archaeological sites.

CASE STUDIES: LONG-TERM PERSERVATION OF ARTIFACTS IN ISRAEL

Bnot Ya'akov Bridge

At the prehistoric archeological site at the Bnot Ya'akov Bridge in the southern Hula Valley of Northern Israel, excavations in 2009 revealed that Lower Paleolithic humans may have lived in the area as early as 790,000 years ago. Archeologists from the Hebrew University of Jerusalem described a layer of early stone-age culture at the excavation site, where numerous flint & stone tools, wood used for fuel, animal bones and plant remains were found. Archeologists claimed that such artifacts provided evidence of "advanced human behavior" more than half a million years earlier than has been previously estimated. [6]

Photo: Aerial view looking north toward the Bnot Ya'akov Bridge and the Hula Valley.

An oscillating freshwater lake indicated by the early to Pleistocene period sediments, existed at the site, where researchers believe primitive man produced the discovered stone tools and butchered and prepared food. In the area of the hearth, other varied domestic activities were event from the wood pieces found in the area used for fuel for fire. Processing of basalt and limestone was restricted to the hearth area, where they also discovered large stone tools such as hand axes, chopping tools, scrapers and awls. [7]

Preservation of these materials was undoubtedly a result of the fact they were made of highly durable materials – in these cases flint and stone. Preservation was also likely supported by the possible submergence in the fresh water lake. It is also of note that at this site, as for the other sites discussed here, these artifacts survived in an area of periodic conflict and war.

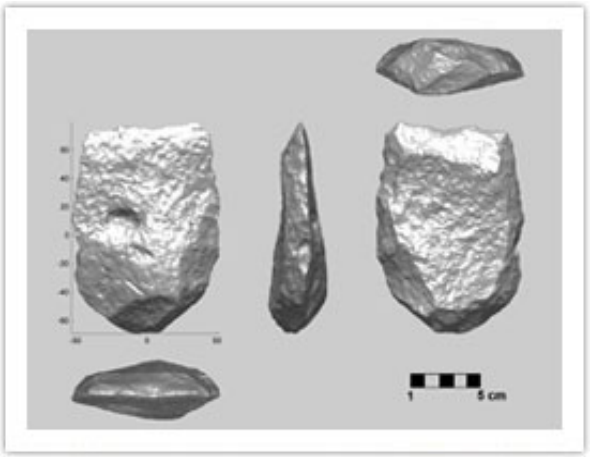
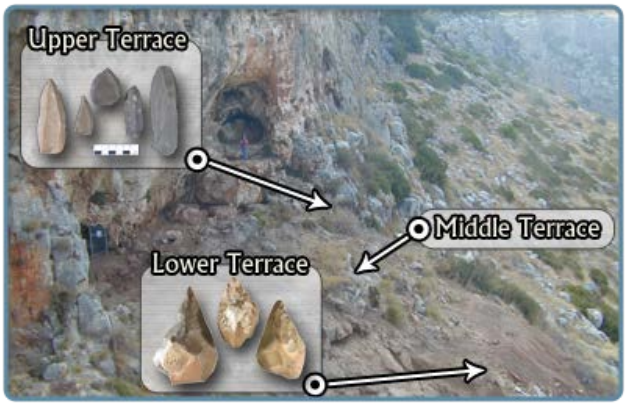


Photo: 3d Model of Basalt Cleaver (Hand axe)

Photo: Excavation on the Jordan River bank.

Misliya Cave

In 2007, archeologists excavating Misliya Cave, located southwest of Mt. Carmel in Northern Israel, unearthed artifacts indicating the existence of one of the earliest known prehistoric men. The team, made up of archeologists and anthropologists from the University of Haifa and Tel Aviv University, discovered hand-held stone tools and blades, in addition to animal bones, which dated back 250,000 years ago – the time of the Middle Paleolithic culture of Neanderthals in Europe. Amidst the layers of the dig site, a large quantity of artifacts was discovered – about 3,000 items per square meter – including tools for hunting and cutting. The amount of artifacts discovered indicated an extensive settlement of the site – a potential center for the region. Bones found may have been the trash of the residents. [8]



The site itself may have once been a large cave. Today, it appears to be a rock overhang carved into a cliff. It's shape however, as well as the flowstones and boulders along the slope, indicate that it may once have been a cave that collapsed in the mid-late Pleistocene period. [9]

The site consisted of a series of layers and terraces with varying types of sediments, including breccias. It is noted that "Breccia was found to be rich in bones and lithics", and bones and lithics were found in pockets at the site. Again the durable materials may have been a major factor in their preservation.

The Tabun Cave ("Cave of the Oven")

Also in the region is the Tabun Cave, which was occupied during the lower and middle Paleolithic ages – from 40,000-500,000 years ago. Deposits of sand, silt and clay up to 25 meters thick accumulated in the cave over a long period of time, with the earliest deposits containing large amounts of sea sand. The presence of sea sand and the pollen traces found indicate to researchers that it was a relatively warm climate. Melting glaciers may have caused the sea level to rise and the Mediterranean coastline to recede. The upper levels of the cave however contain mostly clay and silt, indicating a colder, more humid climate. Tools for cutting and sawing, such as small flint tools, were found in the upper strata of the cave – from 200,000 to 45,000 years ago. The cave also containes one of the most ancient human skeletal remains found in Israel, a Neanderthal-type burial of a female dated 120,000 years ago. [10]

Hayonim Cave

Many archeological sites in Israel have artifacts dating back to the Neolithic period, between 8500-4300 BCE, when people of the Natufian culture spread across present-day Syria, Israel and Lebanon and began practicing agriculture. One such site in Israel is the Hayomin Cave, a large Paleoltithic site in Northern Israel. Flint artifacts, as well as animal bone and wood ash, which are rich in phosphate and carbonate compounds, were found at the site.

The mineral components of bones and burned wood are highly susceptible to dissolution and recrystallization, based on the acidic sedimentary conditions in which they are buried. Based on the composition of the surrounding sediment and soil, bones and wooden ash may not be able to survive. The site demonstrated variations in the abundance of bones found in the thick Mousterian layer of the cave. Infra-red analyses of the minerals in the sediments "identify zones of advanced diagenesis and decomposition alongside zones whose chemistry clearly favored the preservation of bones and wood ash." [11]

Uneven spatial distributions of the sediments in the area may be a reason for different preservation conditions and the varying abundance of bone artifacts. The bones that have remained are in good condition, and researchers concluded that "Good preservation environments can be distinguished from poorer ones on the basis of mineral assemblages in sediments, and deposits that once contained bone and wood ash can be identified long after the visible traces of these materials have disappeared." [12]

CONCLUSIONS

The presented case studies include sites with artifacts preserved after hundreds of thousands of years. Regardless of the period, culture, climate and/or any other associated environmental conditions, most of the surviving artifacts were tools made of stone and quite often flint. This is not surprising if we take into consideration that flint (made of quartz) is the hardest, most widely available material in the natural world. In addition, since this material is widely distributed and readily available, it's purchasing value is low, so it is not a subject of theft or robbery. In addition, in three of our case studies the artifacts were found to be present in caves (the oldest most common known shelter), protected from the surrounding environment.

Taking clues from these artifacts, it is clear that a modern marker system should adopt these essential best practices in order to withstand the test of time – be constructed from strong, hard and inexpensive material to avoid the inevitable looting and theft, and protected by cave-like or similarly durable shelter made of similar material in order to avoid harm from surrounding man-made and environmental threats.

While this combination of factors may not seem surprising when considering the long-term survival of building materials, these real-life case studies show us from experience which types of materials and which conditions allow man-made items to stand the true test of time. In looking forward, these are our primary clues to what modern markers will be able to withstand natural and manmade disasters, conflicts or environment that we can not anticipate today. While the materials and methods for preservation available today are of course far more advanced that what was available to our ancestors, the same will most likely be true to future generations. It is therefore essential that we take these examples from our past as we seek methods for a modern, permanent marker system for a geologic nuclear waste repository.

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